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**HOW
AND
WHY**

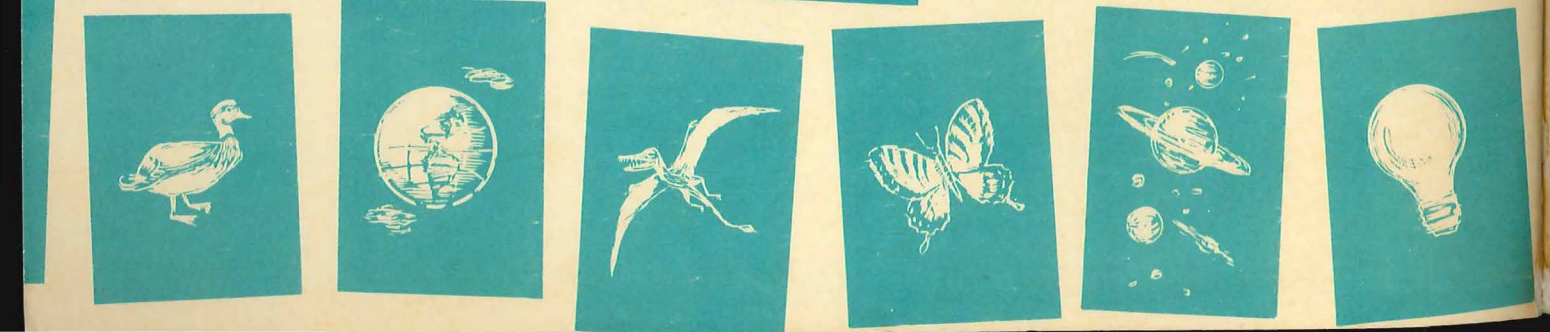
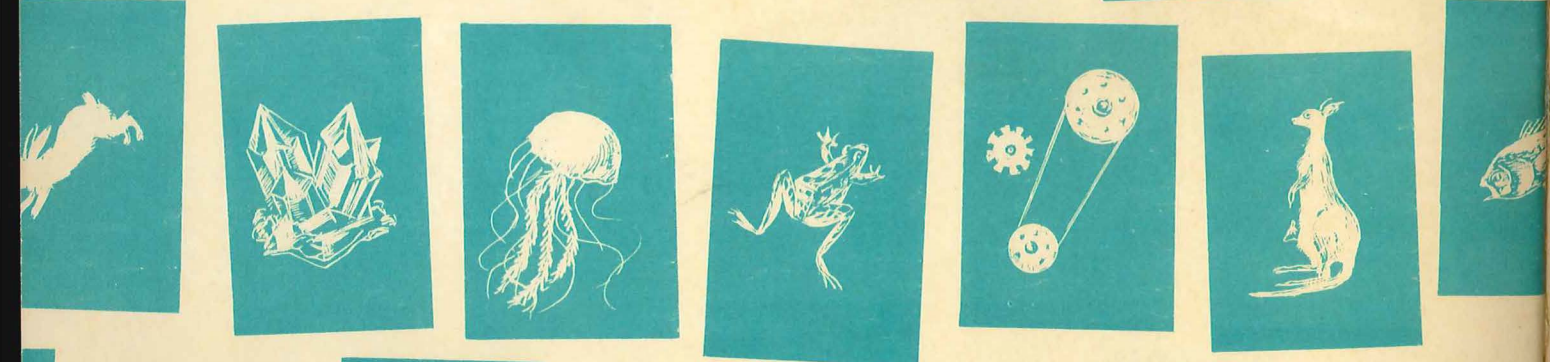
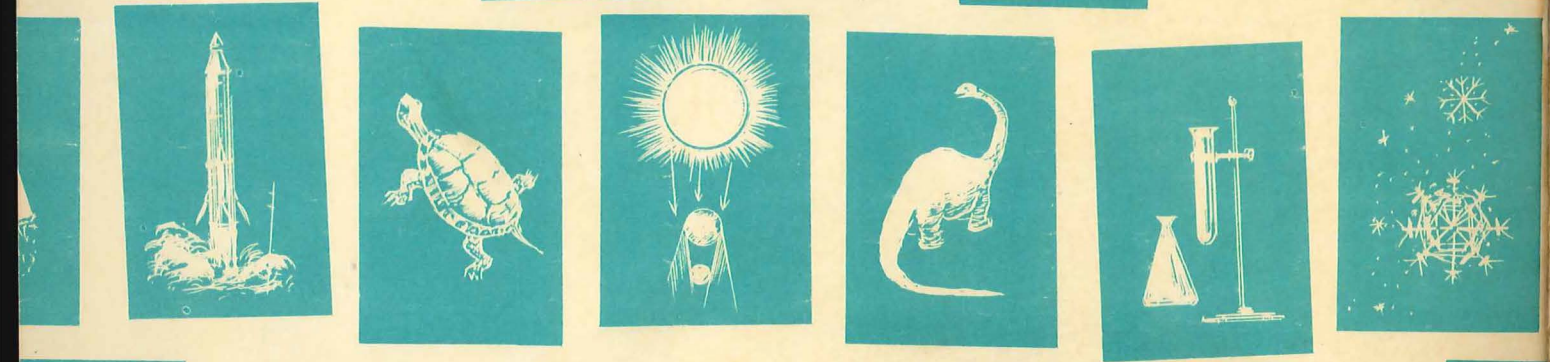
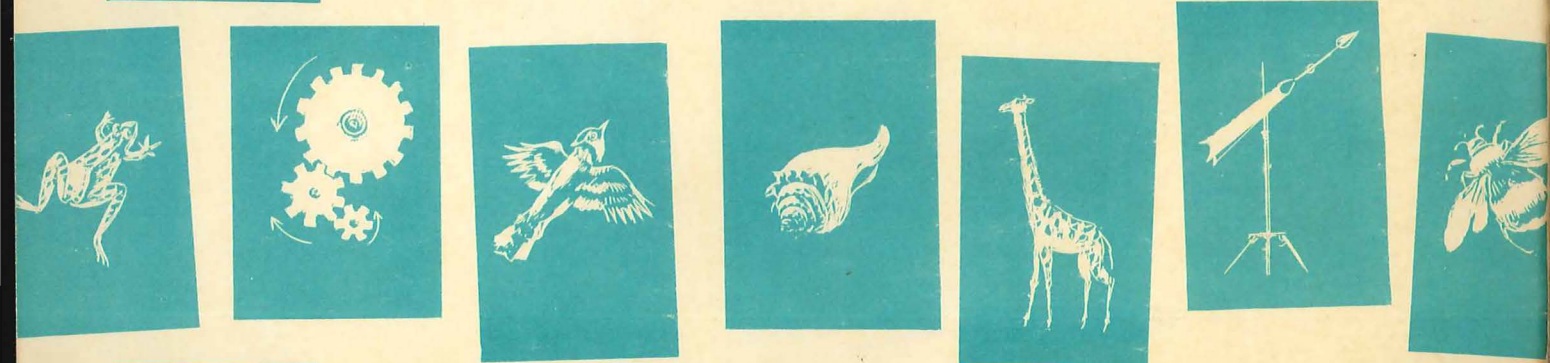
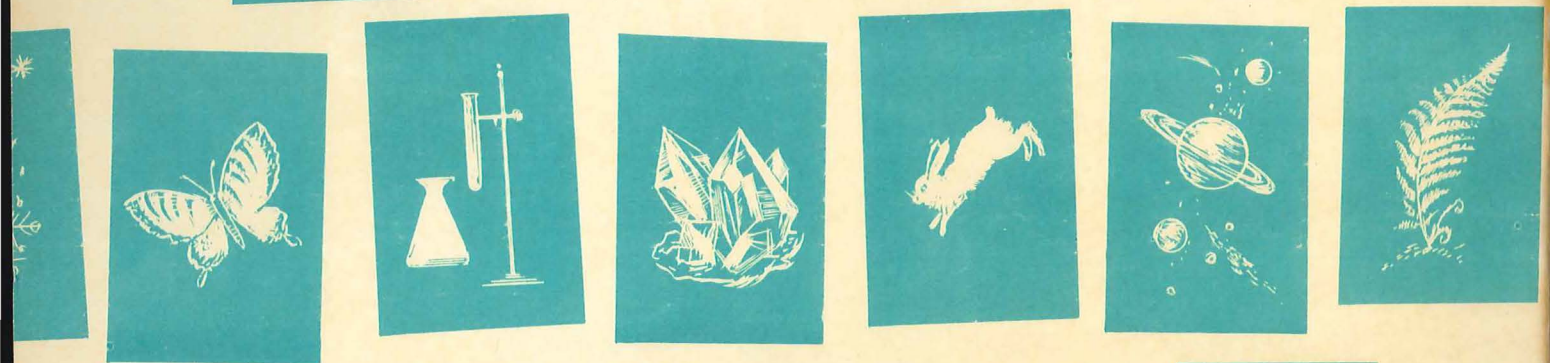
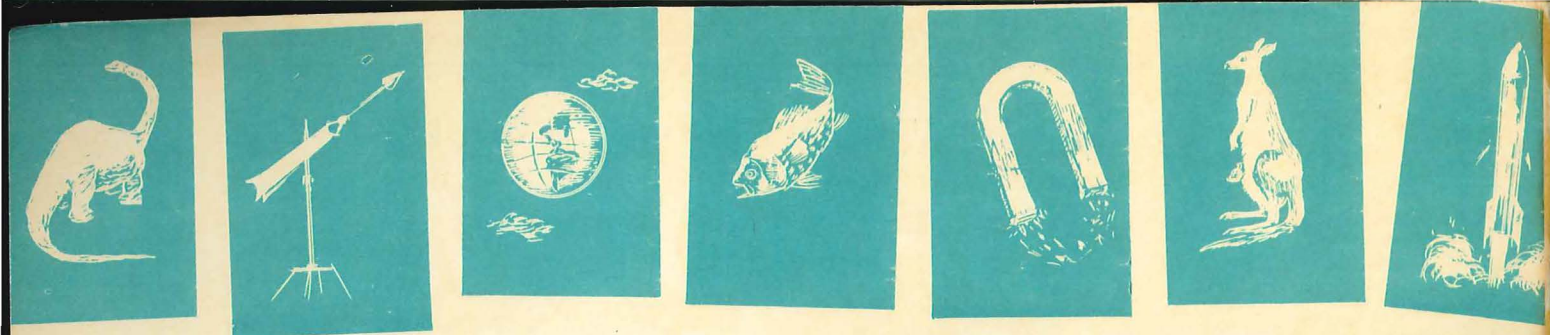
Wonder Book of

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MUSHROOMS FERNS and MOSSES

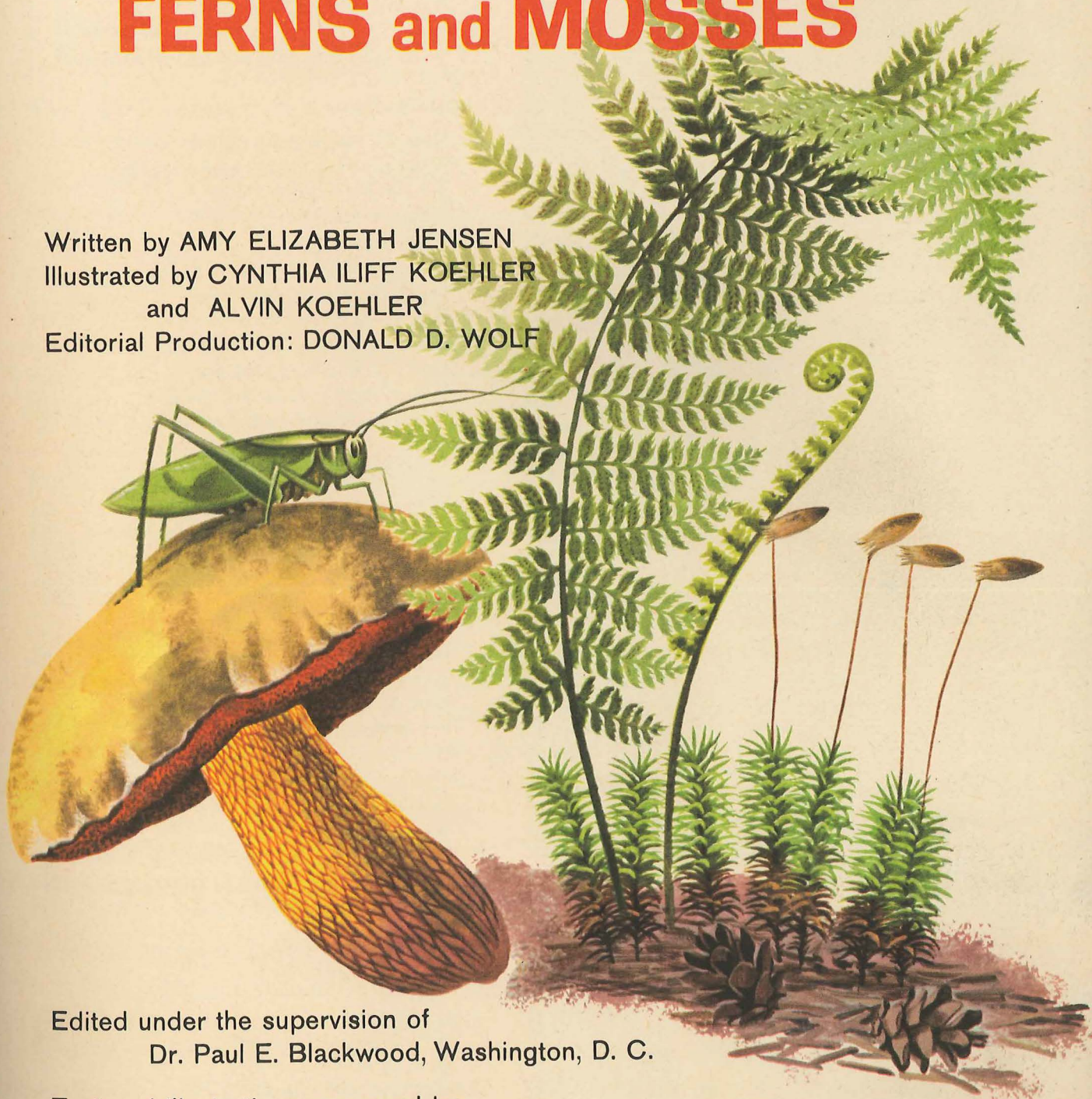




THE HOW AND WHY WONDER BOOK OF

MUSHROOMS FERNS and MOSSES

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Introduction

The study of our amazing universe is taking us down many different roads. The knowledge we gather along one path differs greatly from what we learn on another. Yet, many of the same laws of nature still apply. We need scientists who will explore the old pathways, too, to help us to a better understanding and application of our present store of knowledge, as well as track down new facts about our universe.

Scientists who have chosen to study plant life are called botanists. They study the structure, function, and classification of plants. What botanists have learned about plants through careful observation and research outstrips the imagination. Remarkable discoveries have resulted from the study of the flowerless mushrooms, ferns, and mosses. Though primitive in many ways, these plants exhibit a tremendous variety of adaptations as they fight to survive throughout the world.

This *How and Why Wonder Book of Mushrooms, Ferns, and Mosses* tells some of the interesting folk tales and superstitions associated with these ancient members of the plant kingdom as it unfolds the science of this abundant but unheralded form of life. The book will be an invaluable reference for budding botanists at home as well as in school — and an adventure for the boy or girl who is “just reading.”

Paul E. Blackwood

Dr. Blackwood is a professional employee in the U. S. Office of Education. This book was edited by him in his private capacity and no official support or endorsement by the Office of Education is intended or should be inferred.

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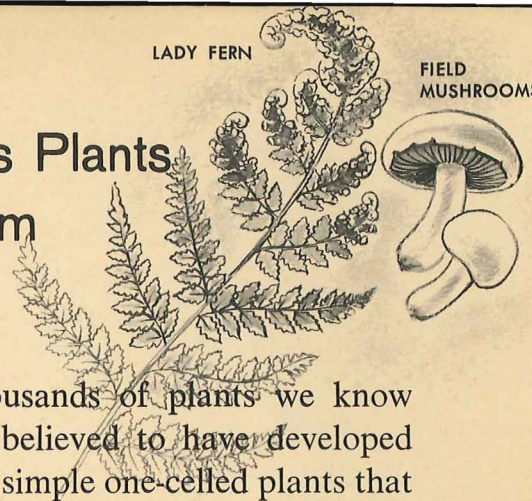
SPHAGNUM
MOSS



The Place of Flowerless Plants in the Plant Kingdom

LADY FERN

FIELD
MUSHROOMS



All living matter is divided into two main groups, the animal kingdom and the plant kingdom. Mushrooms, ferns, and mosses belong to the plant kingdom. They are old members of the plant community; their direct ancestors go back to the very beginnings of life. As they do not have seed-producing flowers, they are called flowerless plants. Before examining them closely, let's have a general look at the "family tree" of the plant kingdom.

The history of plants is an ancient one. The first plants came into being about two billion years ago, and nobody is sure exactly how they looked or precisely how they developed. But there are theories about it which are more or less generally accepted today.

The most primitive plants formed in the sea, probably as soft, jelly-like, colorless single cells called *protophytae*, which means "first plants." Judging from the simplest plants now known, we must assume that these first ones were similar to them. As today's primitive species have no hard parts, the first plants most likely did not have any hard parts either, which explains the fact that fossils of these first plants have never been found; only the hard parts would have left any imprint or been otherwise preserved. Early rock formations carry very few remains that can be attributed with certainty to simpler plants.

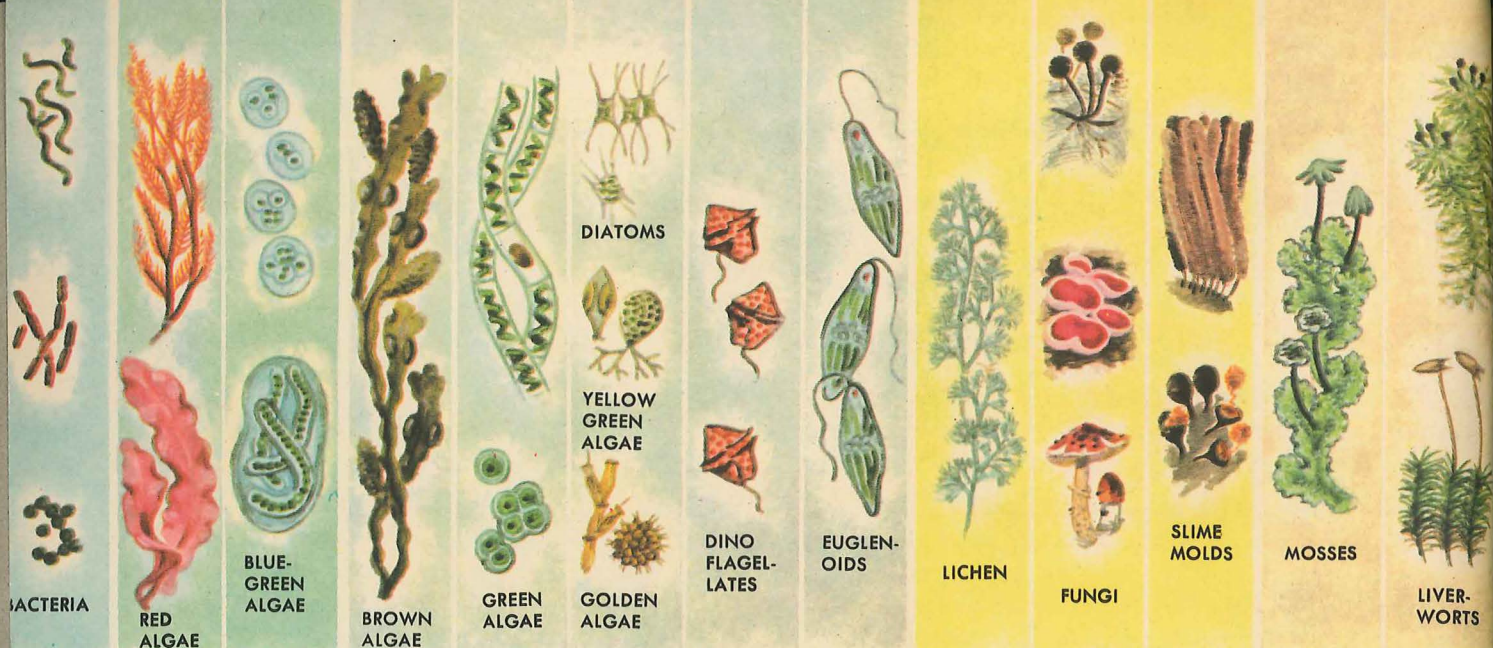
The thousands of plants we know today are believed to have developed from these simple one-celled plants that lived for ages in the waters back in the days when the earth was young. Some forms of such simple plants still exist. They are stragglers along the line of evolutionary progress, having changed little in millions of years from the plants they descend from.

As time went on, a big change came about in the aquatic plants. They developed the ability to manufacture their own food. What enables them to do this is "plant green," a chemical substance we call chlorophyll. With this, the aquatic plants developed more toward the forms we know today, but they still lived only in the water.

The earliest aquatic plants were algae. They had no roots through which to take up the elements they needed to produce their food; they got their support and nourishment from the water through the surface of their cell tissue. The reproduction of these early primitive organisms was very simple and, after millions of years, algae still reproduce in the same way. One cell divides into two cells; they soon separate to make two plants; and so on. The green scum, for instance, you may have seen in standing waters is a species of such algae, and the waters of the Red Sea appear red because of the reddish algae living in it.

ONE-CELLED ALGAE





NO SIGNS OF LIVING ORGANISMS
EXCEPT POSSIBLY:

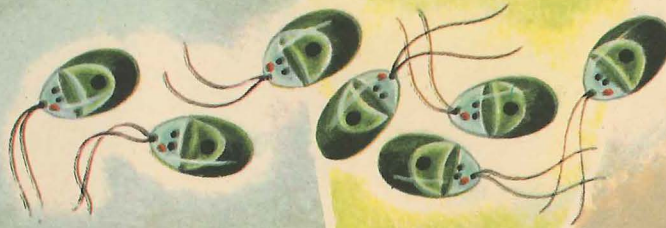


FIRST BACTERIA



FIRST ALGAE

ANCESTRAL BLUE-GREEN ALGAE
(FIRST OXYGEN-PRODUCING ORGANISMS)



GREEN ALGAE — FLAGELLATES
(FIRST CELL ORGANIZATIONS
WITH CHLOROPHYLL)

MORE THAN ONE BILLION YEARS AGO

ABOUT ONE BILLION YEARS AGO

ABOUT 500 MILLION YEARS AGO

THALLOPHYTA

THE SIMPLEST AND MOST PRIMITIVE OF ALL PLANTS, THEY DO
NOT FORM EMBRYOS, AND MOST OF THEM ARE WATER PLANTS.

ARCHAEOZOIC ERA

PRE-CAMBRIAN PERIOD

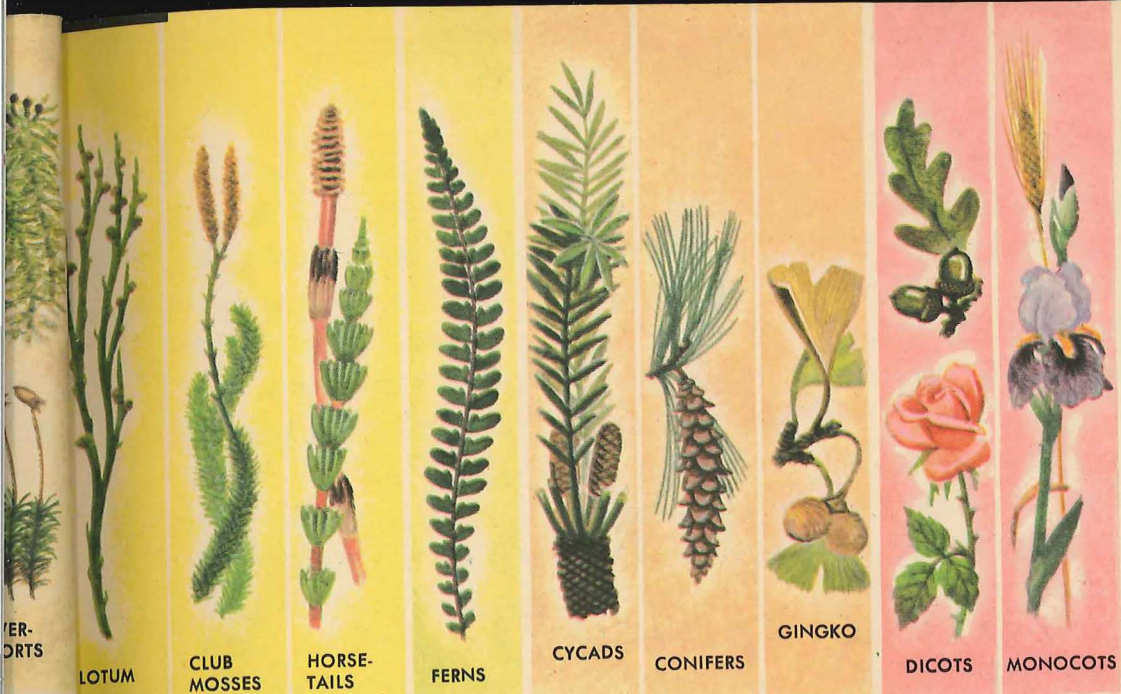
The next step in evolution seems to have been that the cells, after dividing, did not split to form another plant. Instead, they clung to each other after division and formed irregular cell colonies, which grouped together in clumps or long, narrow ribbons. Since they had no protection against drying out, they had to stay in the water. Some of them attached themselves to the ocean floor by means of little shoots they developed. (The seaweed we know today is a salt water descendant of these early algae cell colonies.) Winds and waves often tossed these early aquatic plants

onto the bare rocks where they dried, shriveled, and died.

“Moss-like Plants,” the first members of the plant kingdom to live on land, appeared millions of

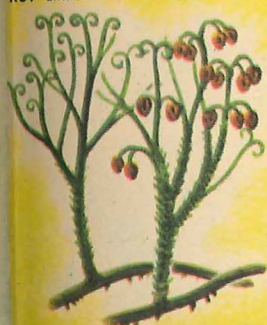
What were the first land plants?

years later. This group consists of the ancestors of today's liverworts, which took the first giant step from the water to the rocky shores and survived the threats of the new hostile surroundings by adapting to them. The tiny, flat, ribbon-like green cells clung to the bare, damp rocks and took in the moisture,



The graphic chart presents the "family tree" of today's plant kingdom with its two subdivisions: the *thallophytes* and the *embryophytes*. Starting from left, we progress from the simplest and most ancient species to the youngest and most highly developed forms. Beneath are some of the major evolutionary changes which have occurred in the plant kingdom. Connection of these key steps with today's living species indicates a probable relationship between the various basic types and their ancestral plants.

FIRST LAND PLANTS (PSILOPHYTON)



ABOUT 325 MILLION YEARS AGO

ANCESTRAL FERNS



ABOUT 300 MILLION YEARS AGO



CYCADS, GINGKOS, CONIFERS (FIRST SEED PLANTS)

ABOUT 210 MILLION YEARS AGO



WILLOWS, MAGNOLIAS, FIG, ETC. (ANGIOSPERMAE) (FIRST FLOWERING SEED PLANTS)

ABOUT 120 MILLION YEARS AGO

EMBRYOPHYTA

MORE ADVANCED PLANTS THAT FORM EMBRYOS AND LIVE ON LAND.

PALEOZOIC ERA

SILURIAN PERIOD

DEVONIAN PERIOD

CARBONIFEROUS PERIOD

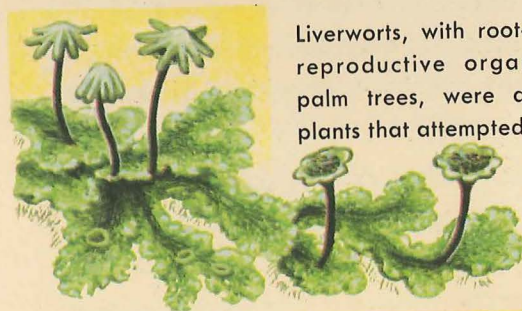
MESOZOIC ERA

CRETACEOUS PERIOD

which saved them from drying out, with all parts of their cell structure.

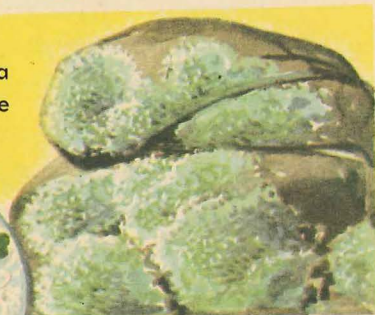
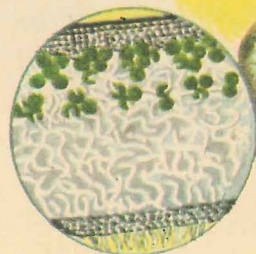
Gradually, some of the plants began to change. They grew root-like threads which anchored them to the rocks. The unprotected mass of cells developed an outer layer of skin, which prevented the precious water from evaporating. The now-protected cell bodies began to resemble little leaves.

Today's liverworts are very similar to the early forms after this adaptation had taken place. They are little more than relics in the plant kingdom. They reproduce by scattering special dust-



Liverworts, with root-like fibers and reproductive organs resembling palm trees, were among the first plants that attempted to live on land.

Right, the *parmelia*, a lichen living on bare rock.



At left, the enlarged cross section shows algae (green) and fungi (white).

like cells, which we call spores, that grow into new plants when they land on a surface with enough moisture.

Again, millions of years passed by. Some of the first flat moss-like plants that had survived on land, adapted, and reproduced began to grow upright instead of staying flat on the ground. The root-like threads, which at first had served only to hold the plant to the rocks, began to drink up life-giving water and minerals from the ground. Slender stems, only an inch or two high, developed to carry the food-building materials to the tiny leaves. Neither of these parts, however, were fully developed at that time.

Today's mosses are descendants of these plants. Their structure is similar, their parts are just slightly more developed, and only their manner of reproduction is a bit more complicated than that of the early forms.

As a general rule, we can observe that the more primitive and simple plants appeared on earth first, and slowly developed into more complex organisms, just as we have described it. First, the tiny one-celled aquatic forms; then, development of the aquatic cell colonies; next, flat, more protected cell structures with root-like anchors; later, beginning roots, stems, and leaves.

Following this pattern, we could expect that the next step in development would be sturdier roots, bigger and stronger stems, and broader leaves. But there were exceptions to the rule. The ancestors of today's lichens had no roots, stems, or leaves. Odd plants, they are formed by a combination of colorless fungi around green algae which live

together in such a close cooperative partnership that they seem to be single plants. They help each other so well that they thrive, even today, where no other plants can survive — on bare rocks. Some species are only tiny green dots flatter than the liverworts; others grow taller than the mosses.

We have learned that, after the first forms, the species of the then small plant kingdom reached a certain higher — if still primitive — level in the mosses, when the lichens, which did not follow the expected pattern of development, appeared. The evolution of the fungi is "a step back," as their organization is a more primitive one. While the bodies of liverworts and mosses had developed different cells with different functions (the cells of the roots differed from the cells of the tiny leaves), the cells in the bodies of the fungi were all alike. They were not divided into roots, stems, and leaves, and the masses of cell tissue had no protective outer skin.

The fungi, which have no chlorophyll, cannot produce their own food and must get their nourishment in one way or another from other plant life. The plants which make their own food adapt to certain surroundings, weather, and soil, and will not grow, with very few exceptions, if their living conditions change drastically. The fungi, however, living off other plants, can flourish in all kinds of places and climates. Fungi today exist in many sizes, shapes, and colors all over the world. The fungi reproduce by way of dispersing spores; the various species have various ways of dropping them.

Of all flowerless plants today, fungi have the most species. There are five times as many different fungi as there are lichens or mosses, and almost ten times as many fungi as there are ferns. Scientists have named more than 70,000 different fungi. Some are visible only under the microscope, others are a couple of feet high, some are poisonous or harmful, and still others are edible or of some use to man. The mold on old bread, the yeast used to make bread rise, the bacteria that causes diseases, and the penicillin that cures diseases are all fungi. Mildew are fungi and so are mushrooms and toadstools, the largest of the fungi. You will read more about them later in this book.

Our trees today are seed-bearers, and they appeared late in the development of the plant kingdom. Before they evolved, there came plants which took up the pattern of development where the mosses had left it. These plants, the horsetails and club mosses, at the end of their development, resembled our trees. They preceded the ferns, to which they are closely related.

They developed bigger roots, taller stems, better leafy structure, and grew to giant heights. They also developed special tubes to carry water and nutrients to their different parts, and stalks with thick covering for protection and prevention of evaporation of moisture. Horsetails have jointed stems and scaly leaves that grow in whirls around the joints; club mosses have slender simple, or branching, stems with small scale-

Were there ever trees that had no seeds?

like green leaves that cling to them. Both plants reproduce by dispersing spores, which distinguishes them from the true trees which came much later.

Today's species, descendants of the horsetail and club moss "trees" of the vast, lush Coal Age forests of almost 300 million years ago, are but dwarf copies of their giant ancestors. The big early species disappeared when climatic changes during the Ice Ages forced the plants of the Coal Age to adapt to a different environment, and caused the evolution of different species and other plants.

The fern was one of these. The highest development reached in flowerless plants, they followed the horsetails and club mosses. Our ferns descend from huge fern "trees" in these forests.

Ferns have sturdy underground stems, feeding ducts, tough roots, and true leaves. Although their reproduction is more complicated than that of the earlier plants, it still does not involve seeds. But the development of the ferns in the Coal Age forests represented the last link to the seed plants, the highest organisms in the plant kingdom, and as you have just learned, comparative late-comers in the evolution of plants.

Our *How and Why Wonder Book of Mushrooms, Ferns, and Mosses* will acquaint you with the plants that do not bear seeds and are called the flowerless plants. They are descendants of the plants which were the milestones on the road of evolution in the plant kingdom.

We will begin with the mushrooms, as they are the most important of the three groups to man and so, should be of the most interest to the reader.



HORSE-
TAIL



CLUB
MOSS



TRUE MOSS

Mushrooms

There are a number of theories about where the name, mushroom, came from. Some believe that mushroom, and the old way of spelling it, *mushromp*, came from two Old English words, *maes* and *rhum*. *Maes* meant "field," and *rhum*, "a thing that bulges." Others interested in etymology, the study of word origins, say that it comes from the French word, *mouche*, which means "fly," because some of the plants have a strong attraction for flies. Again others — and that seems the most likely to us — say it came from the old French word, *mousseron*, which means "moss."

How did the mushroom get its name?

As some mushrooms hide under a living carpet of moss for protection and food, mushrooms might have been confused in early times with the moss itself, or might have been considered a part of it.

Long ago, especially in medieval times, the mushroom, always considered something special by superstitious folk in Europe, stimulated the imagination. Most unusual tales were told about the plants. A story about the Fairy-ring Mushroom was related in various versions. You may have seen

What are some "mushroom myths"?



these Fairy-rings in fields, meadows, or even right in your own yard. Perhaps you have heard the pretty name, Fairy-ring Mushroom, in songs, poems, or stories. People used to believe that the rings were the nightly gathering places of frolicsome gossamer-winged fairies and their gay elfin companions. It is easy to picture a pack of mischievous sprites in nocturnal revels, performing dainty dances on Fairy-ring platforms against the backdrop of a woodland scene.

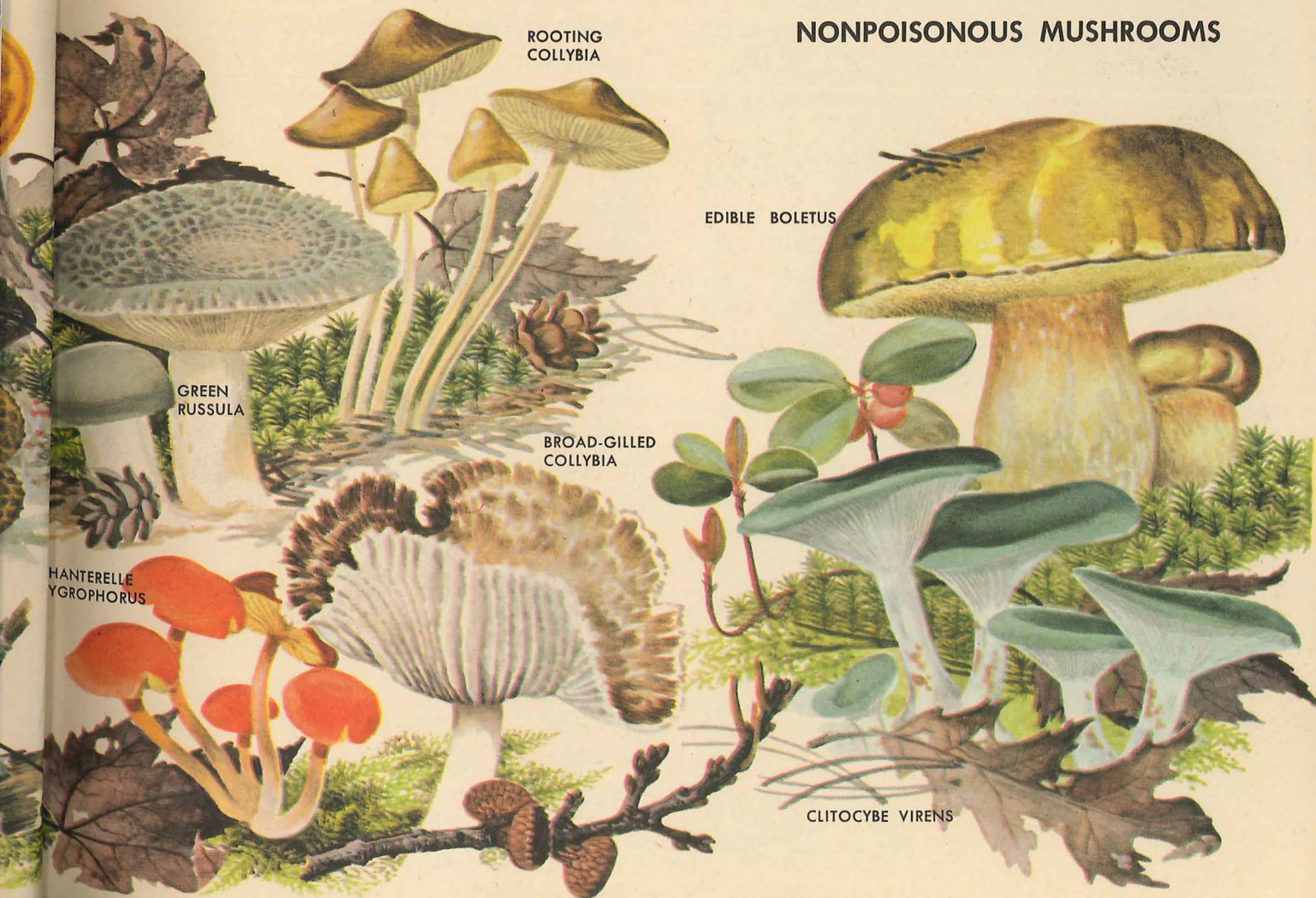
French peasants refused to enter these rings for fear they would encounter gigantic ugly toads with large protruding eyes. In Germany, superstition marked these bare spots as the nightly resting places of dreadful drag-

ons that breathed living fire that scorched the grass around them.

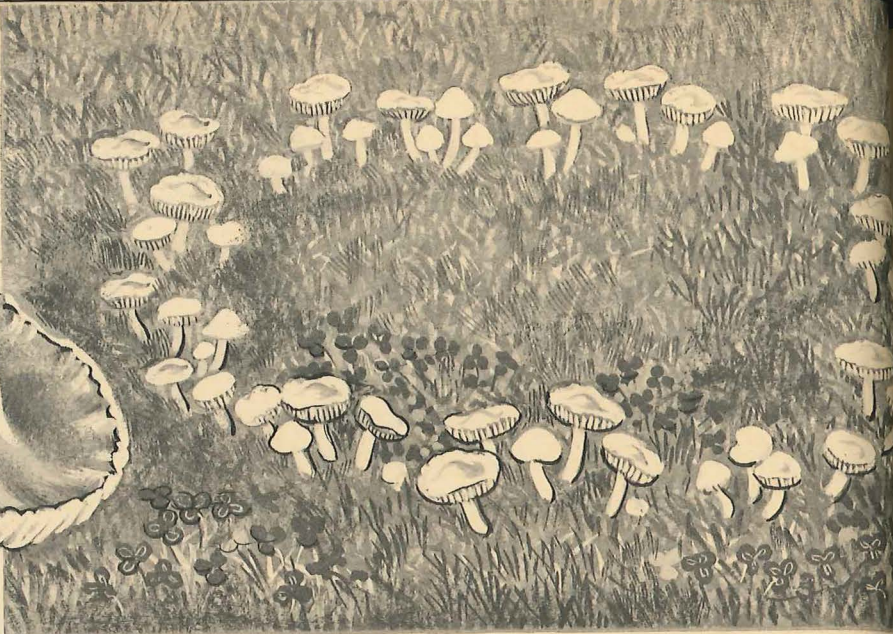
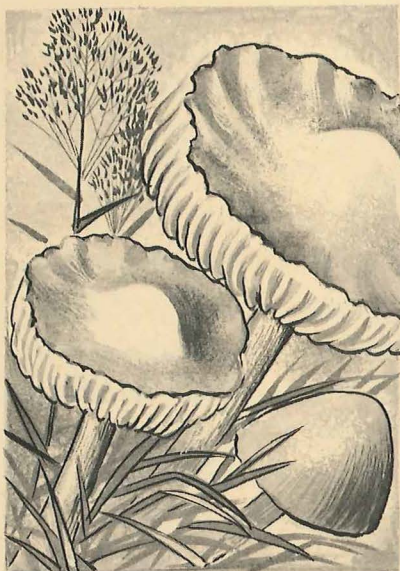
Then, too, people thought that within these Fairy-rings, gnomes buried wonderful treasures which one could find only with the help of kindly fairies or scheming witches.

Today, we know that Fairy-rings are really a disease of grass caused by various species of mushrooms. Sometimes, these circles measure hundreds of feet in diameter, and take as many years to form. They grow a few inches or so a year in favorable conditions. If a species of mushroom grows in a meadow (and mushroom colonies usually grow in circles), grass feeds on the mushroom and gets a food different from grass that does not feed on mushrooms. This

NONPOISONOUS MUSHROOMS



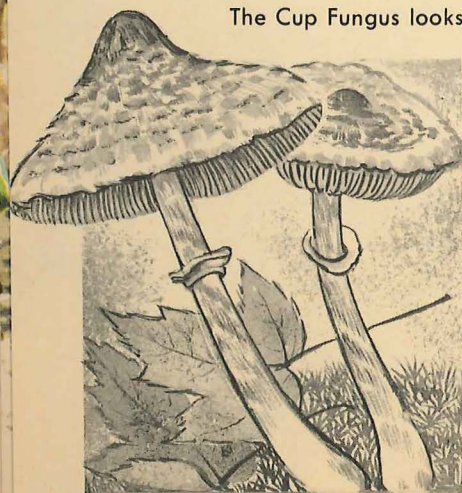
FAIRY-RING MUSHROOM



makes the grass taller and greener than the surrounding grass. Later, when the mushrooms multiply and use up all the water and nourishment themselves, the grass dies and a bare patch appears. As the mushrooms die and decay, the process is repeated. After many years, you will notice bare rings at one time, and rings formed of greener, higher grass at other times. There is another species of mushroom which causes only rings of richer grass, and still another species that affects the grass very little.

So much about the Fairy-rings. We hope that our scientific explanation adds to your pleasure in studying them.

PARASOL MUSHROOM



The Cup Fungus looks like a little goblet.



CUP FUNGUS

Other kinds of mushrooms inspired other superstitions. The Parasol Mushroom, an umbrella-shaped plant, was thought to be used as rain umbrellas or sun parasols by tiny creatures, or just as resting places after gamboling on the green. Mushrooms which look like small goblets were believed to be used by nymphs to sip the cool morning dew, and larger ones were thought to tip to furnish refreshing showers for them. There are poisonous toadstools from which evil spirits were supposed to brew dangerous drink.

In many countries, strange and primitive medicines, surgical dressings, anesthetics, and cures for many ailments were made from mushrooms. Puffball Mushrooms, also nicknamed Smokeballs or Devil's Snuffboxes, were used by the early American settlers to stop bleeding. (For illus., see pp. 8 and 16.)

Scientists in modern times have done much to dispel these superstitions, and have succeeded in exposing mushroom medicine as sheer quackery. But still, the strange plants have a fascination that exceeds biological interest for many people, and even after many of the myths have been disproved, they live on

in the common names of the plants and in literature.

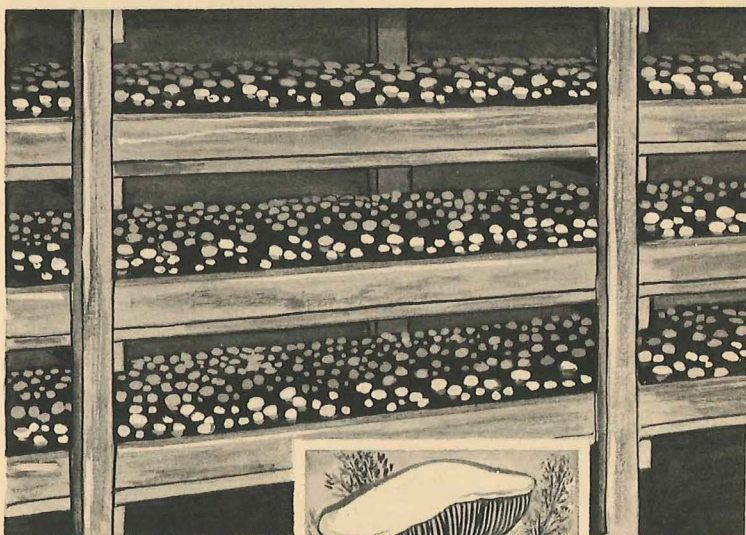
Let's not forget that the use of mushrooms — beyond eating them — was not always based on superstition. The Brackets once served as tinder, razor strops, cork, chest-protectors, dyes, and snuffs; and artists still like to draw on the Sketcher's Mushroom, or Drawing Pad, as it is also popularly called. They sketch on the creamy underside or cut sculptural scenes on the upper surface. As the plant turns hard and woody, the sketch or the sculpture is preserved and gives a special effect. Try it if you find this kind of mushroom and it is in the right stage, not too soft yet not too woody. (For illustration, see p. 19.)

There are many kinds of mushrooms that are used as food, especially in Europe. However, *only experienced collectors* should ever gather them. The numerous edible species grow mostly in fields and meadows. Some other edible varieties can be found on tree stumps and decaying logs. There are mushrooms that, although not poisonous, are too unwholesome to eat. The edible mushrooms range in taste from mild or sweet to very peppery. The latter usually lose their bite when cooked. The cream-colored Field Mushroom, the common table mushroom, is often cultivated commercially. Among the most delicious wild mushrooms is the cone-shaped, flesh-colored Morel, which, because of its wrinkled and ridged surface, is often also called the Sponge Mushroom. You can eat the edible mushrooms fresh, canned, dried,

Are all mushrooms edible?

or pickled; and there are quite a number of housewives in Europe who would not part with their special mushroom recipes for all the money in the world.

Most poisonous kinds are found in the woods. Unfortunately, there are those that look so much like some edible ones that only a botanist can distinguish between them. Such a killer is the pearly-white Destroying Angel; its poison acts like that of a rattlesnake. The beautiful yellow, orange, or red Fly



The common Field Mushroom is often cultivated commercially in "mushroom barns."



Mushroom, once used to kill flies, is another in this group.

People used to speak of all poisonous species as toadstools and edible ones as mushrooms. Now, however, botanists call all kinds mushrooms, whether poisonous or not and no matter what their form. (For illustrations of some better known edible mushrooms which are not herein described, see pages 9-10; for some of the poisonous, see pages 12-13.)

GOBLET MUSHROOM



TROPICAL LUMINOUS MUSHROOM



DAYTIME



AT NIGHT



DAYTIME



AT NIGHT

JACK-O-LANTERN

An interesting phenomenon is the glowing light that issues from the gills, mycelium, or other parts of certain mushrooms. It gives one an eerie feeling to come upon such shining formations when traveling through the woods at night. If enough of these luminescent plants are located in one spot, it is actually possible to read by the light they give. They have even served as emergency safety lamps, as a means of marking a way through the woods, as personal adornment for women of the South Sea Islands, and have many other such uses. The Lamp Mushroom (*Pleurotus phosphoreus*) casts a soft pale white light from its lower surfaces as it discharges its spores. It shines only while alive, possibly to attract insects. The Jack-O-Lantern (*Clitocybe illudens*) throws a pale green light from its gills as it generates heat. Like flowers, mushrooms have distinctive aromas. The more pleasant ones may remind you of chestnut blossoms, violets, camphor, fruit, or anis. The exquisite reddish yellow funnel-shaped Goblet Mushroom (*Cantharellus cibarius*), for instance, smells faintly of ripe apricots or plums. The Stinkhorn (*Phallus duplicatus*) is an example of those mushrooms with offensive odors. You may have noticed it in back yards or under open stairways.

SOME WELL-KNOWN POISONOUS MUSHROOMS:

AMANITOPSIS VAGINATA

FLY RUSSULA

STINKHORN

EMETIC RUSSULA



GLISTENING INK CAP



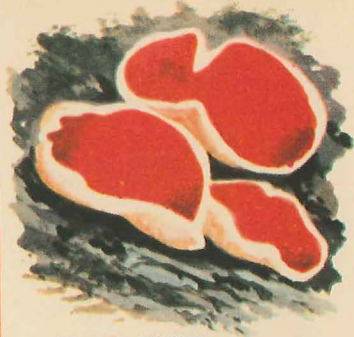
BIRD'S NEST FUNGUS



DESTROYING ANGEL



SCARLET SAUCER



BEAR'S HEAD



FOX FIRE



LACTARIUS PIPERATUS



OYSTER MUSHROOM



CAESAR'S AMANITA



SADDLE MUSHROOM



LEPIOTA MOLYBDITES

AMANITA PHALLOIDES



RUSSULA FOETENS

There is the amazing number of about 38,000 kinds of mushrooms in the world! A thousand or so of these are found in the United States. Many of them can be discovered on your rambles through fields and woods, on walks in your neighborhood, or right in your own yard.

Some of these odd plants are as small as pinheads. If you study the midribs of grasses and dead leaves carefully, you may find some tiny ones. Some gain diameters of several feet and many pounds in weight and appear bloated. On dead trees and stumps, there are often clusters of mushrooms measuring several feet across. Certain mushrooms seem to rest on the ground, showing no stem. Others, such as the Thin One (*Marasmius androscaeus*), have long stems as fine as horsehair. There are pygmies like the *Marasmius capillaris* and giants such as the Giant Puffball (*Calvatia gigantea*). There are mushrooms with fantastic shapes: the Bird's Nest Fungus (*Crucibulum vulgare*) resembles a miniature bird's nest filled with eggs; the Saddle Mushroom (*Helvella elastica*), a saddle; the Oyster Mushroom (*Pleurotus ostreatus*), oysters; and there are many other unusual forms. They bear such nicknames as Satyr's Beard (*Hydnum erinaceus*), Dead Men's Fingers (*Mutinus curtisii*), and other colorful titles. Of course, each has a scientific Latin or Greek name which tells its order, family, genus, and species.

No artist's palette is daubed with a vaster array of gorgeous colors than are found in mushrooms. Some are white such as the frosty Bear's Head (*Hydnum capu-ursi*); others range from pale pastels, bright yellow, brilliant orange, ruby red, and indigo blue to emerald green.

The caps of some are frilled; others, like Caesar's Amanita (*Amanita caesaria*), are fluted; many are accordion-pleated.

The life cycle of most mushrooms is the same, even if there are variations in form and construction. We have chosen the Field Mushroom as an example. Its solid, fleshy, silky, white, clammy umbrella cap has thin spoke-like plates (gills) on its underside. On these ridges, many tiny brown cells (spores) develop. These spores are carried on stalks that grow from the surface of the gills. They have the same function as seeds in seed-bearing plants. After one or two days, a single spore, which is enclosed in a wall, ripens and falls from the side of one of the protective pocket-like folds. If there is no wind to carry it away, it settles at the base of the parent plant to await suitable conditions for its growth, which usually takes place during the warm, wet weather of spring.

However, usually such a spore is likely to start on a long journey with the many, many other spores produced by the parent plant. This simple cell is finer than a speck of dust, so even a

gentle breeze can waft it into the sky and carry it hundreds and hundreds of feet above the ground. Although this mushroom spore is a minute particle, it is so built that changes in temperature cannot easily harm it.

When the wind dies down, the spore floats lightly down to earth after its aerial journey. It drops into a deep crevice in a wide meadow.

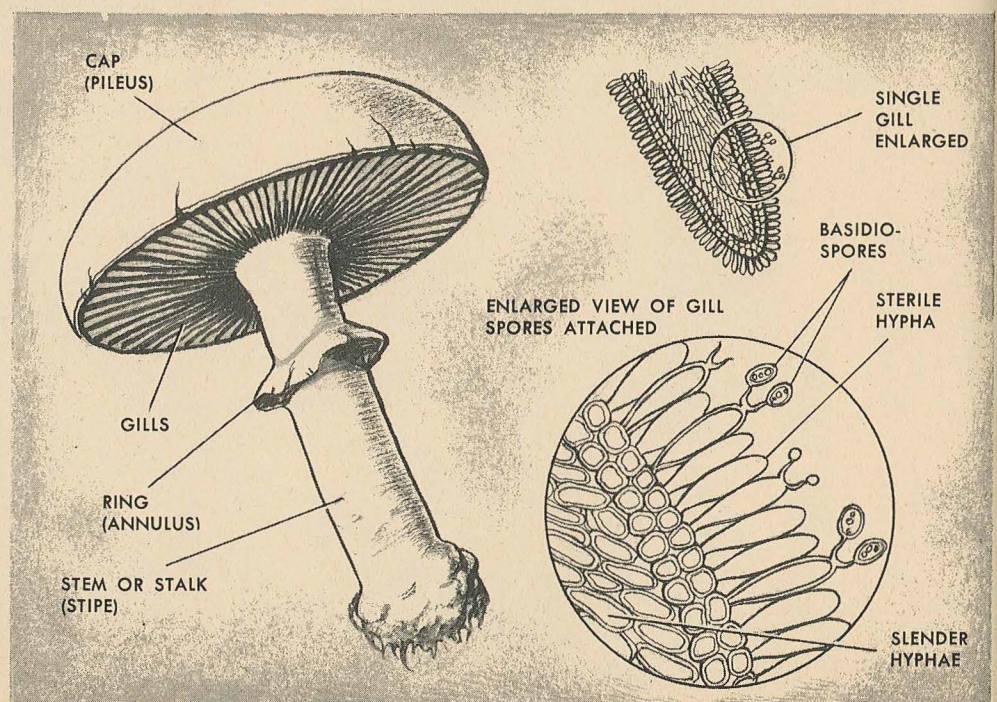
The same wind, which only yesterday transported this tiny spore on its flight, now blows up bits of dust and dirt that cover it. The spore remains there with some of the others which left the parent plant at the same time and accompanied it on its journey. During the long, cold winter, they are covered by a soft blanket of snow.

The warm spring sun melts the snow, and causes tiny rivers of cold water to rush over the meadow. Some of the spores are lost in this deluge, but some have been pushed down into the crack so deeply that they escape. From the

What are spores?

What is mycelium?

The knobs (fructifications), which eventually appear on the mycelium, grow and develop into an enlarged basal stalk (stipe) and a flattened cap (pileus). On the underside of the pileus appear the gills on which the spores are produced. The gills are usually protected during their development by a skin which, when the mushroom grows, ruptures along the margin of the cap, producing a ring of tissue (annulus) around the stalk.



spore, a plant begins to grow. It feeds for a short time on the food stored inside it. Awakened and given new life by warmth and moisture, it swells. This bit of living material absorbs food from dead plant substance through its walls. It then divides and becomes two cells. As each new cell takes in food, it, in turn, divides. This multiplication by division continues until long links of vine-like cells are formed. They are so fine they can be seen only through the magnifying eye of a microscope. These white hair-like fibers, looking like roots, stretch out one by one in all directions to get food. Each one develops by itself, but all become entwined into a feathery white network, which forms the vegetative part, or mycelium, of the plant. These fine threads push themselves through the ground.

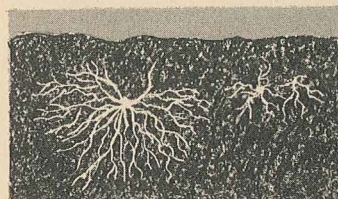
At certain points on this tangled web, the fibers pack together and a swelling forms at one side. It is a white tissue-like knob the size of a pinhead. This knob increases in size until it becomes a button with a stem. As the button enlarges, a small pocket develops at the tip. Some of the threads grow

**Is the mushroom
the plant or
its fruit?**

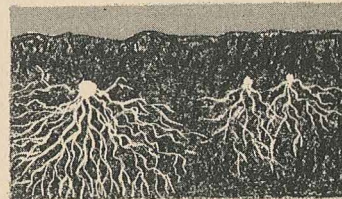
the fibers pack together and a swelling forms at one side. It is a white

into this little opening and become gills. A veil of threads extends from the stem to the edge of the cap and protects the gills until the spores are ripe. More nourishment is supplied, and now the button grows rapidly.

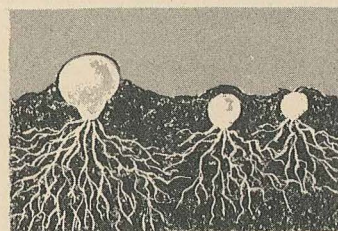
Some months later, on a warm, muggy summer day, the mushroom stretches up and comes through the ground as a white marble-sized blob. As it grows, it looks more like a dumb-bell. The veil protecting the delicate gills breaks as the cap expands. A part of it is left as a ring on the thick-set stem. It tapers at its base; the rest of it hangs like a fringe from the smooth,



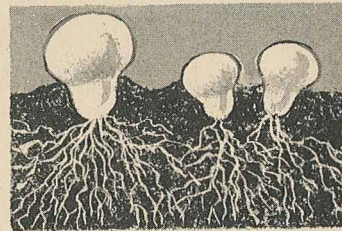
GERMINATING SPORE



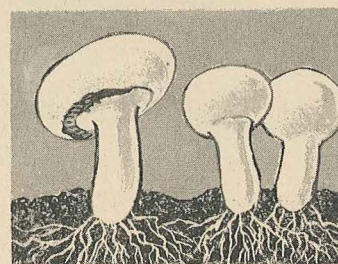
DEVELOPING MYCELIUM



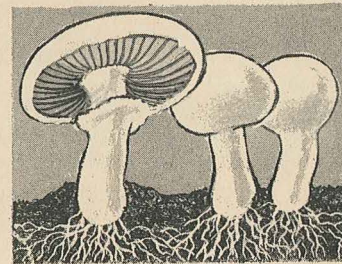
BUD APPEARS ABOVE GROUND



BUD GROWS



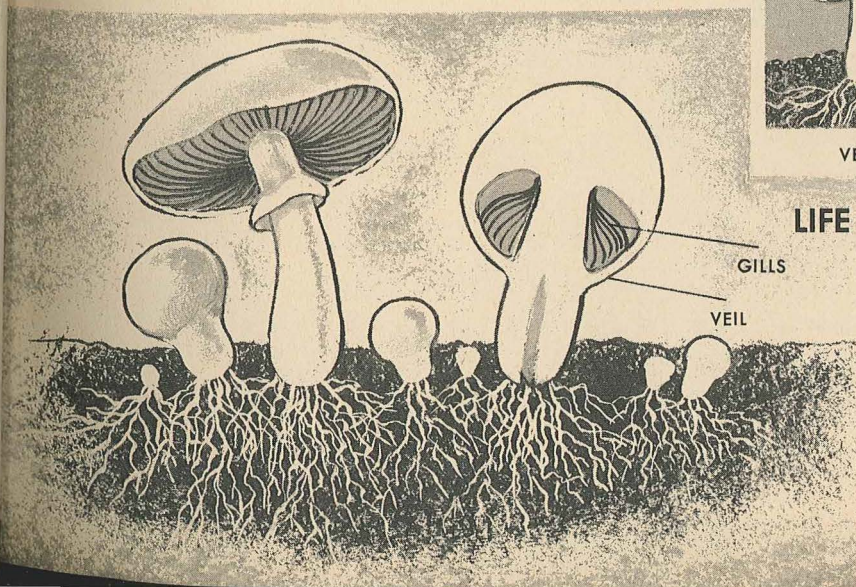
VEIL HAS RUPTURED



MATURE MUSHROOM SHEDS SPORES

LIFE CYCLE OF THE MUSHROOM

At left, mushrooms, buds, mycelium with fructifications.



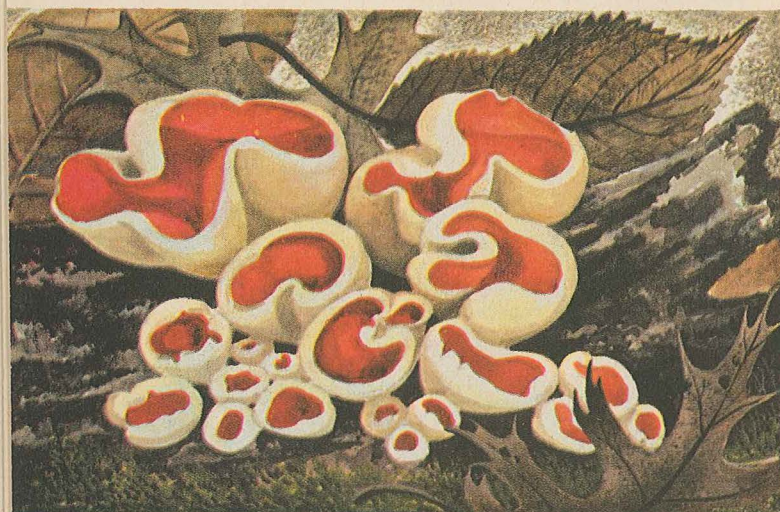
Coral mushrooms form their spores on the clusters of the upright branches.



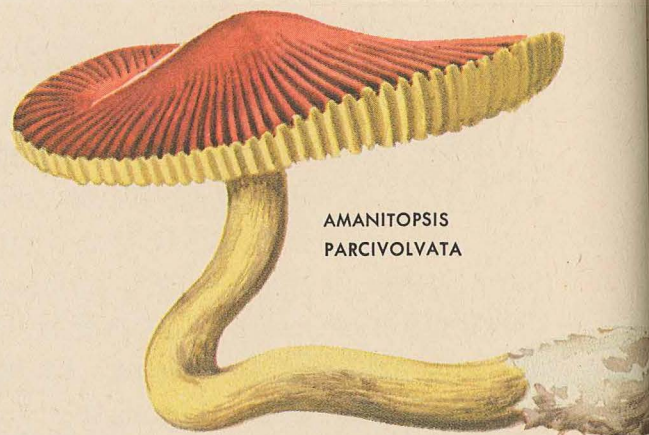
PINE CONE MUSHROOM



UNDERSIDE OF CAP OF
PINE CONE MUSHROOM



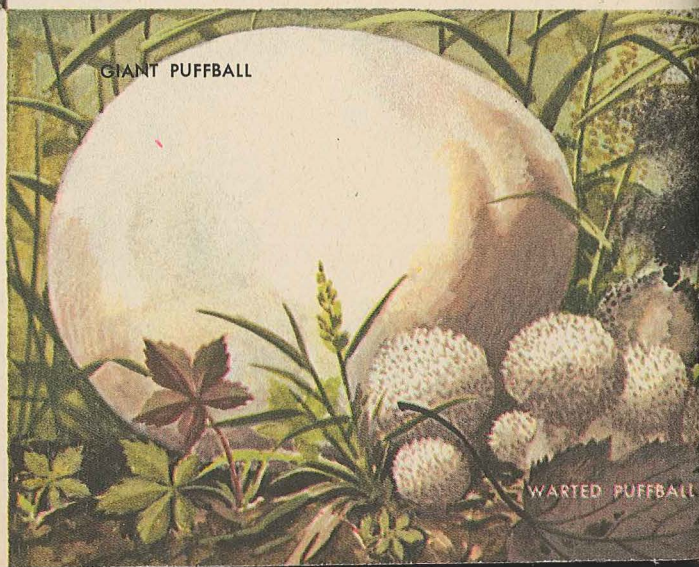
The Cup Fungi form their spores on the surface of the cups; they pop out when ripe.



AMANITOPSIS
PARCIVOLVATA

No matter how a mushroom grows or drops its spores, the cap has to be in an upright position.

The Puffball mushrooms have no gills or pores — not even a stem. When you tap a ripe Puffball, a cloud of microscopic spores will "explode."



GIANT PUFFBALL

WARTED PUFFBALL

skin-covered cap. The gills now become pink in color.

The mushroom, which is really the fruit of the plant, is now ready to drop its spores and become a parent. With enough food, moisture, and warmth, the mycelium will live and send up new crops. Its life cycle completed, the mushroom's gills turn purple or dark brown, and brown, scaly triangles appear on its cap. Dying, it changes from an attractive and interesting plant into a soft, slimy, black mass of decay. It gives back some of the nourishment it took by fertilizing the soil and making it richer.

Not all mushrooms drop their spores

Do all mushrooms have gills?

from gills; some send them out in different ways. The many-branched Coral Mushroom emits its spores from wrinkled surfaces. Others, such as the Pine Cone Mushroom, contain their spores in tubes. Others emit them from plain surfaces or teeth. By studying mushrooms closely, you can find out how they release their spores.

In some, spore dispersal is very interesting. Certain *Ascomycetes* shoot their spore from sacs. The hissing, explosive noise frightens the insect inhabitants of the neighborhood into flight. In others, the spore case is shot off, as a sac to which it is attached aims at a bright spot of light. No matter how a mushroom drops its spores, it must be in an upright position. You can check this yourself by laying a mushroom on its side. Note how, after some time, it lifts

its cap to a position which would permit it to release its spores.

A single plant may produce as many as 16 billion spores. Trillions and trillions of spores of different sizes, shapes, and colors, and with different surface markings, are transported by insects, birds, animals, and even man in various shipping activities. Some of them even cross oceans and reach foreign shores. The air is filled with these tiny bodies, but they are visible only when they fall in a mass on some surface. Fortunately, nature applies her law of balance, and for every one that grows, billions are wasted in one way or another. If they all survived, there would be myriads of mushrooms, and we would be living in a different sort of world, a crowded plant world.

The spores that do live seek homes in swamps, on mossy rocks, on burnt-over ground, or in rich manure, in almost any kind of soil, on roadsides and streets, on the floors of deep ravines, in pastures, on sunny lawns, on live and dead trees, in old mines, and many other places. They even live on each other. The only place they are not found is where there are no plants; they need them, dead or alive, for nourishment.

Mushrooms obtain their food from many sources.

How do mushrooms get their food?

They grow where there are ample material and water available for their use. They have no green coloring matter (chlorophyll) with which other plants, with the sun's light, manufac-

ture food. Because they, too, need starch, sugar, and other nourishing elements, they must steal food directly from plants, or indirectly from the animals that have fed upon them.

The robber mushrooms, such as the Honey Mushroom, which feeds off live trees, plants, or other living things, are known as parasites. Since such dependent plants are limited by their "hosts," the smaller mushrooms are usually found in this group. Some of these are harmful because they destroy the trees in forests and orchards. If a tree is injured, bruised, or has any kind of opening in it, drifting spores may enter it; they then start a mycelium which pushes its way into the tree in all directions to get food. Strength ebbs out of the tree, it cannot withstand the wind, and it is often blown down. When mycelium threads reach the living ring of a tree's trunk, the tree will die. After these fibers spread in a tree, they hunt for an opening from which they can push out mushrooms. The Scaly Polypore is one of the tree parasites that forms mushrooms in curving shelves.

Sometimes a mycelium lives in partnership with a plant, shrub, or tree. It will then form a covering around the roots of one of these and become a part of the root cells themselves. The mushroom draws its nourishment from the plant, shrub, or tree and, in return, supplies food to its roots. If you see mushrooms at the bases of trees or shrubs, or close to other plants, dig them up. You may find that they are living on them.

Saprophytes are scavenger mushrooms and usually grow larger than the parasite ones. They live on tree stumps,

logs, posts, manure, withered leaves, grass, dead plants, or on any decaying matter. One interesting type is the Train Wrecker, which inhabits and damages wooden railroad ties unless the ties are treated so that spores will not develop. Mushrooms that make their home on decaying wood are a help to man. Were it not for them and other fungi, the forests would be crowded with dead wood. After these plants have taken nourishment from dead stumps and branches, these parts decay and fertilize the soil.

The various kinds of mushrooms re-

quire varying
When and where amounts of
do mushrooms grow? heat, food,

water, light, and air. The latter two elements are least important in their growth. Most plants flourish in the warm, wet weather of spring, summer, or fall; only a few thrive in the winter. The small, beautiful Water-Measuring Earth-Star changes with the weather. Its thick outer coat parts to expose a ball in the center. When the air is moist, the plant opens so that its jelly-like points, four to twenty in number and from two to three inches in width, lie flat or turn under the body, thus lifting it from the ground. When the air is dry, however, the lining hardens, and the points curl up and close.

Some mushrooms are found only in the tropics, where it is warm. Others are constructed so that they can withstand weather in temperate or cold regions. Certain mushrooms are annuals (plants which complete their growth in a single year). The Sketcher's Mushroom is a perennial; it grows year after

year, adding a circle on its hard, woody surface for each year. If you are lucky enough to find any of these mushrooms, you can count the rings to see how old they are.

Contrary to popular belief, mushrooms do not pop up overnight. In fact, some require years to

reach their full maturity. Much of their development takes place where it cannot be seen — under soil, in wood, or in vegetable matter. This is its true growth when it makes new tissue. The stem and fruit, which are really a continuation of the interwoven threads of the mycelium, grow rapidly, but they are only parts of the whole plant. Their rapid growth is really the expansion of already formed tissue.

Thousands of threads absorb water when the plants are fruiting. This system may become inactive in winter or dry weather. When conditions are right for growth again, it begins its work once more. Unlike other plants that have only a few layers, mushrooms have a number of expansion points. Their organs can be filled quickly with water to stretch at the right time. Because of this power obtained with the plants' absorption of food and water, certain kinds of mushrooms have been known to displace paving blocks weighing several pounds, break up sidewalks, push stones from their resting places, and perform other Herculean feats of strength as a clump expands.

It is interesting to watch the develop-



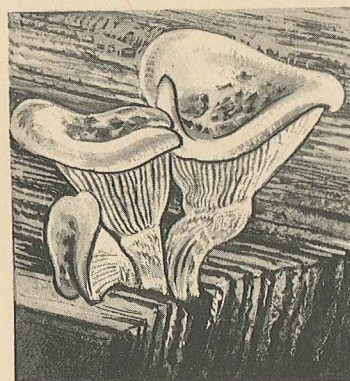
HONEY MUSHROOM
(*ARMILLARIA MELLEA*)



SHELF MUSHROOM
SCALY POLYPORUS

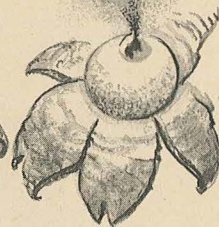
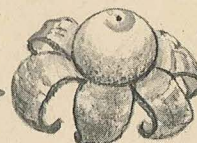
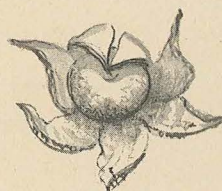


Scaly Polypore and cut-away of tree showing how the mycelium destroys the tree tissue.



WOOD HEDGEHOG
(A SCAVENGER)

TRAIN WRECKER (*LENTINUS LEPIDUS*)



WATER-MEASURING EARTH-STAR
(*GEASTER HYGROMETRICUS*)

SKETCHER'S MUSHROOM OR DRAWING PAD
(*POLYPORUS APPANATUS*)



ment of mushrooms of many sizes, shapes, and colors. When full-grown, they drop white, pink, brown, purple, or black spores, thus starting the life cycle all over again.

Some mushrooms live for centuries, but most do not last long. If you handle them, you will see that they are delicate and easily crushed or torn. Consisting of about seventy to ninety per cent water, they are soon parched by the strong rays of the sun or hot, dry winds. They die, to decay and enrich the soil. Flies, beetles, ants, slugs, tortoises, mice, rabbits, red squirrels, sheep, cattle, and deer feast on fresh, or decayed, mushrooms.

If you cut thin slices from some mushroom plants over a period of time, you can see the different stages of development of the fruit.

By collecting mushrooms, you can learn

**How to start a
mushroom collection**

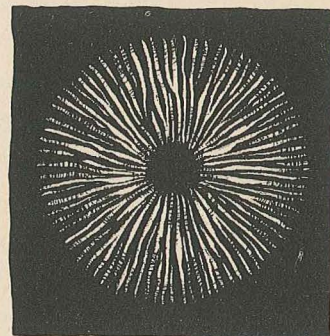
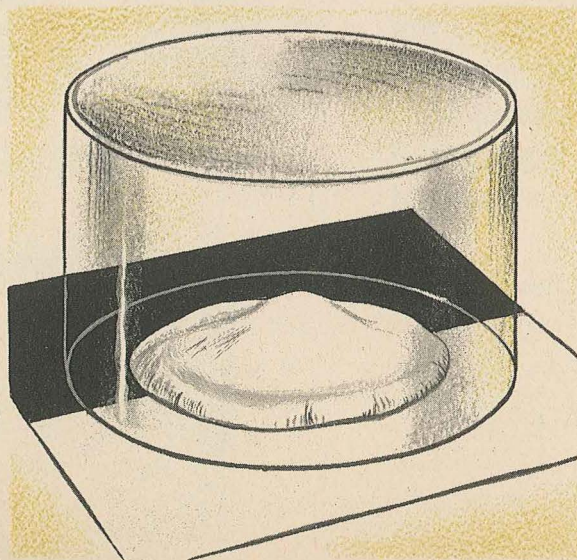
to recognize the common ones, as well as some of the more unusual species. Like other plants, they have special seasons and places in which they grow. In some locations, you can find certain types any time of the year. The best time to collect them, though, is during

the autumn from the middle of September until winter sets in. Gather them early in the morning before insects invade them.

Wear old gloves when handling the plants. Take a trowel to dig up those that grow in the ground. A hammer, chisel, and stout knife are needed to obtain some of the others. Include samples in all stages of growth because of the changes in passing from young to old that we have described. Avoid old, flabby, or decayed specimens. Use a clean cloth to wipe them and remove any dirt and insects. Break open the caps and split the stems lengthwise to examine for fly or beetle larvae. If there are maggots in the stems, cut them off; throw the plants away if you find any in the caps. Place the small ones in cardboard boxes or tins with a packing of moss, paper, or leaves. Keep the specimens upright. Handle them carefully so you do not lose any parts or make fingerprints on them.

Record as much information as possible while you see the plants in their natural settings. Noting the habitat, growth habits, size, color, shape, spore dispersal, and other characteristics will help you to identify them. If you make a colored sketch and a spore print, you

**MAKING A
SPORE PRINT**



will have a permanent collection even after you have thrown the plants away. Mount the pictures, spore prints, and other information on stiff sheets of paper of standard size and put them in a loose-leaf album, card index, or box. Excellent reference books, with much detail and many helpful illustrations, on making collections of this sort are available at your local library.

You can make a print that shows how a mushroom drops its spores. Cut off its cap close to the top of the stem. Lay half of the gill side on a piece of

How can you make a mushroom spore print?

fuzzy white paper or a sheet coated with thin glue, gum arabic, or egg white, and the other half on a piece of black paper of the same kind. Cover the parts with a glass to keep out the air, placing a piece of wet cotton at the side to keep them from drying out. If left for several hours, a pattern of the moist spores — in some cases, colored — will stick to the paper. These prints, with their delicate lines radiating from the center, are very beautiful. If the gills protrude below the edge of the cap, raise the cap slightly by keeping it suspended above the paper. Toothpicks — resting on cork supports in the cap — will do the trick.



The World of Ferns

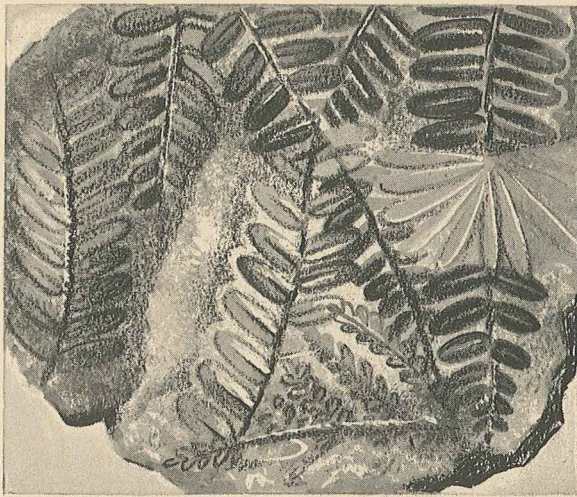
In spring, nature gets ready for her annual show of exquisite lace, the ferns. During this season of awakening, the young ferns stir the dead leaves in sheltered nooks, peek through the ground covering, line the margins of streams, cling to the sides of cliffs and ravines, blanket the fields, and push through marshes and bogs. By the middle of April, millions of tiny plants, looking like coiled green serpents, stretch and unroll.

Over 10,000 ferns have been described and classified by botanists all over the world. About 300 of them are found in the United States. There are few parts of the world, except real des-

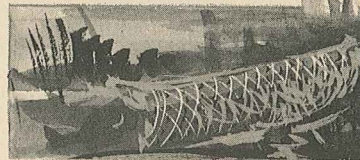
erts, that do not have some species of fern. Even in the cold lands beyond the Arctic Circle, there are more than twenty-five kinds. The largest and most interesting are found in the tropics and temperate zones of the South Pacific. Wee, filmy ferns of the *Trichomanes* genera grow in the Gulf States. These, and others that grow in our country, make a fascinating study.

The family line of ferns is a very long one. Ferns are among the world's oldest living organisms. Three hundred and fifty million years ago, they and their relatives were the principal land plants. Most of

What were the ancestors of today's ferns?



Coal Age forest and fossil imprint of fern parts.



them have been crowded out by higher forms of life and have disappeared. Ferns were the first plants to possess roots, stems, and leaves. The ferns that survived are the highest order of flowerless plants, and are considered the link between mosses and seed plants.

These plants flourished in the warm, moist atmosphere that enveloped the earth ages ago. Vast, luxuriant fern forests filled swampy lowlands and river valleys with lush vegetation. They grew from the Equator to the poles. The large woody, but weak, trunks of broad-leaved, tree-like ferns crashed and fell to earth before the onslaught of spring floods, and layers of leaves and stems slowly filled swamps and marshes. After a long time, under the pressure of beds of sand and mud, their remains changed to peat and, finally, to coal. In the Coal Age, it required a 150-year-old deposit of this material to form a foot-thick layer of soft coal. Today, coal deposits nearly always contain fossil imprints of fern parts. If you live in the states of West Virginia, Ohio, Pennsylvania, or

Illinois, you may be able to collect some fossil ferns. Some museums have exhibits of coal and rock fossil ferns on display.

Some of these prints are very similar to the ferns living now; others are more like flowering plants. These imprints are especially numerous in "coal-balls," the stony lumps found in veins of coal. It was once believed that coal was formed mostly of ferns, but scientists now think that these plants made a lesser contribution to the making of coal. However, they did play some part in it, so it can be said that ferns have been important to industry, transportation, and chemistry as fuel. Some of today's energy actually comes from ferns that lived, died, and were buried millions of years ago.

The people of early times believed in

many myths
What are some
myths about ferns? about ferns.

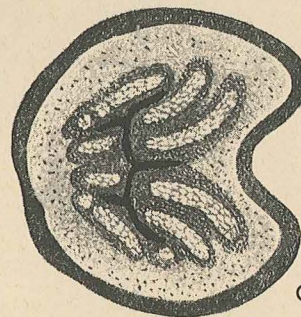
Many were told
about Brackens, the common ferns. A
cross section of the stem of one of these



plants shows a curious arrangement of the plant's ducts' tissues, which looks like the letter "C." Superstitious folk thought that, because the root bore Christ's initial, the plant protected them from witches and goblins. Some Scots, however, saw in these tissues the mark of the devil's hoof. Others imagined that it resembled an oak tree, and that is why it is sometimes called King Charles in the Oak. King Charles once escaped his enemies by hiding in the thick foliage of just such a tree. Another belief was that the more perfect this picture appeared to one, the greater his luck. You might try to find such a fern and cut it slant-wise to see what kind of a figure it has.

Other legends tell about Seed Ferns. They were reputed to have had dainty blue flowers that bloomed only one night a year. Just at the stroke of midnight on Midsummer's Eve, these blossoms ripened, and their shining "seed" dropped to the ground. If one could catch some of this "seed" on a white cloth, he would henceforth possess mag-

ical powers. If a pinch were put on the shoes, their wearer was supposed to be invisible and able to travel anywhere without being seen. It was also thought that fern "seed" gave "second sight" to



Cross section through stem of Bracken showing the "C."

look into the past and future, find lost things, and know where to hunt for buried treasure.

The Moonwort was known as Blasting Root. People thought that the strongest locks would give way if brought into contact with it, and that it could even unshoe horses. The shape of its leaves showed it to be "under the influence of the moon," and so it was believed that if the plant were gathered by that heavenly body's light, it would cure lunacy.

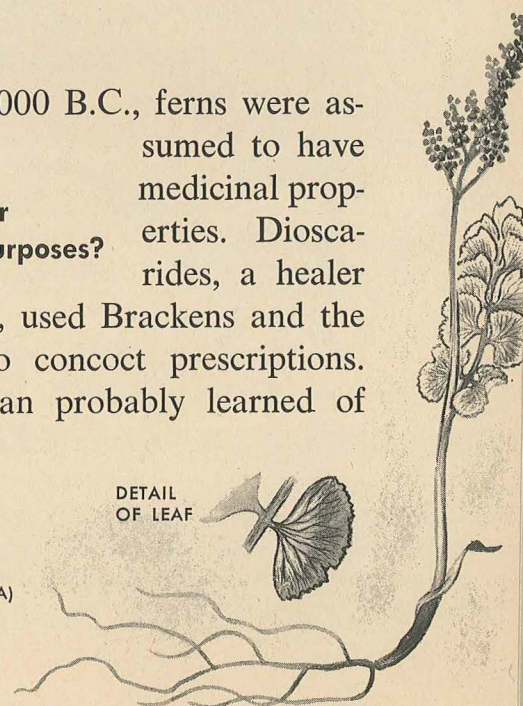
As early as 3000 B.C., ferns were assumed to have medicinal properties. Dioscorides, a healer in Nero's day, used Brackens and the Male Fern to concoct prescriptions. The white man probably learned of

Were ferns ever used for medicinal purposes?

assumed to have medicinal properties. Dioscorides, a healer

in Nero's day, used Brackens and the Male Fern to concoct prescriptions. The white man probably learned of

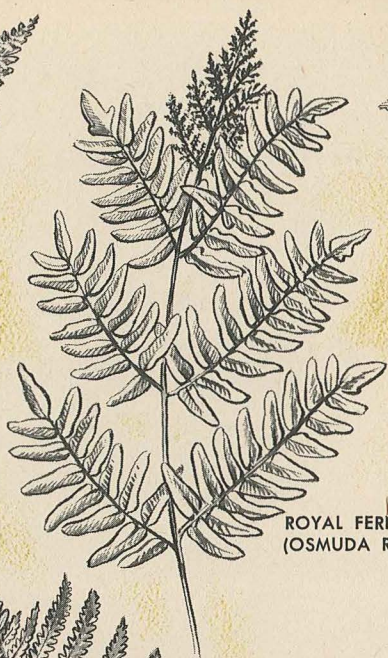
MOONWORT OR BLASTING ROOT (BOTRYCHIUM LUNARIA)



MALE FERN
(*DRYOPTERIS FILIX-MAS*)



ROYAL FERN
(*OSMUDA REGALIS*)



BRACKEN
(*PTERIS AQUILINA*)



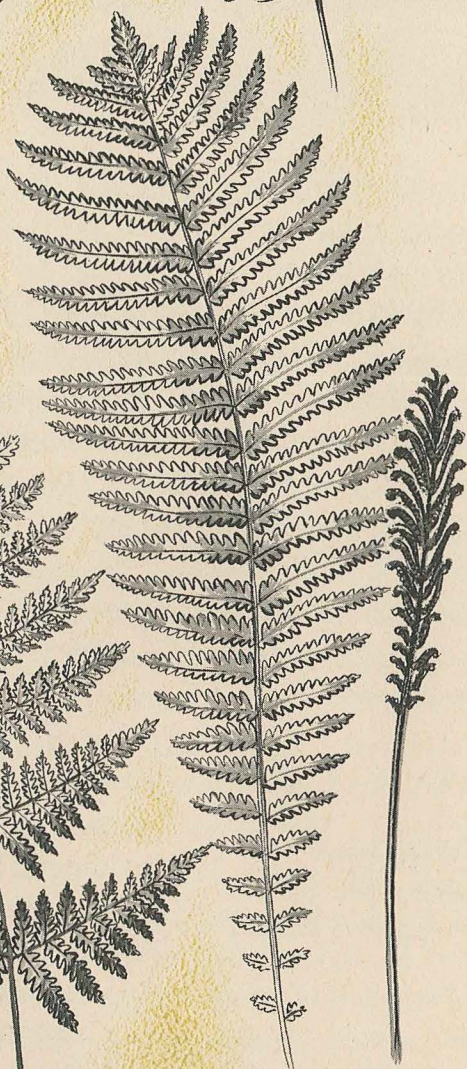
EBONY SPLEENWORT
(*ASPLENIUM*)



RATTLESNAKE FERN
(*BOTRYCHIUM VIRGINIANUM*)



WOOD SHIELD FERN
(*ASPIDIUM SPINULOSUM*)

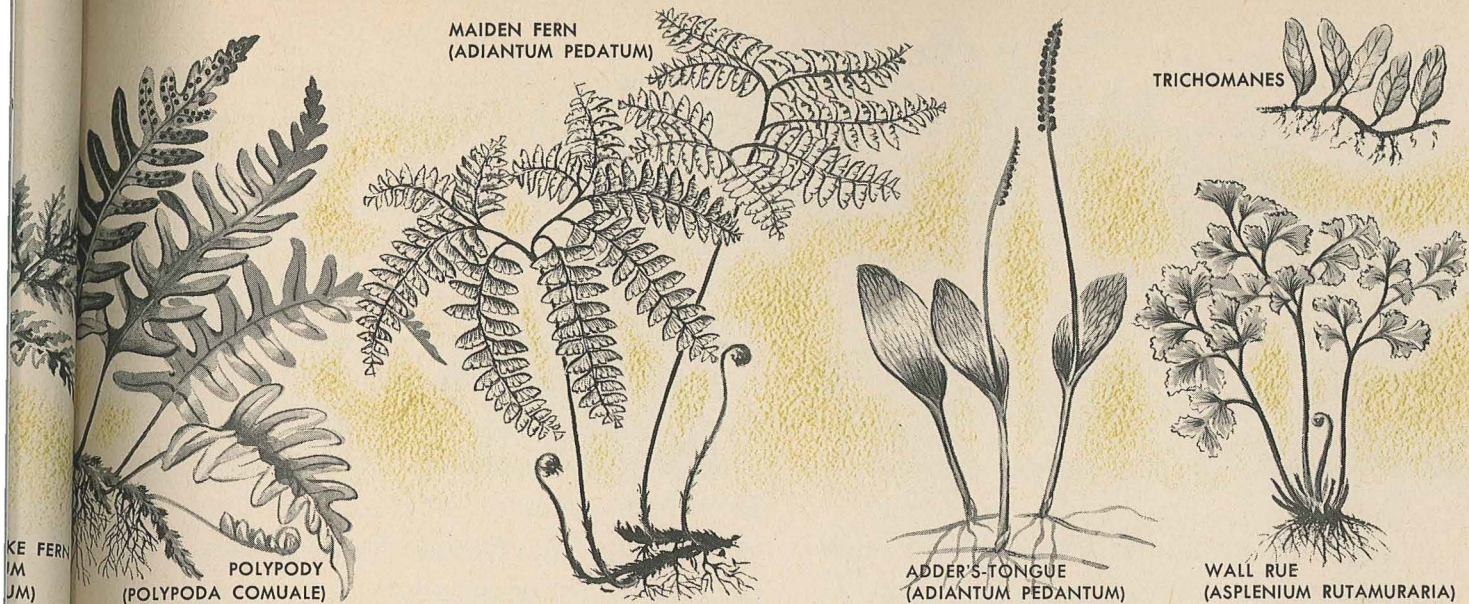


OSTRICH FERN
(*PTERITIS NODULOSA*)

Ferns have common names such as Adder's-tongue Fern, Rattlesnake Fern, Maidenhair Fern, Golden Locks, etc. They also have Latin names consisting of two words: the first names the genus; the second indicates the species.

ferns as cures from the Indians; the natives used them as astringents and in cases of difficult breathing. The *Poly-pody* was once considered valuable as a medicine for chest diseases and, boiled with sugar, as a remedy for whooping cough. It was also used as relief for the "blues" and to ward off bad dreams. In Europe, the Fragrant Fern was made into a tea to prevent scurvy. An *Asplenium* was used to relieve coughs, treating diseases of spleen, and cure a disease called "taint." The rootstock of *Dryopteris Filix-mas* yielded the Filix-mas of pharmacists, an old remedy for tapeworm. In the Old World, it was once believed that biting the first leaves of some of the large Brackens would prevent toothache for a year. The leaves of the Adder's-tongue were at one time the principal ingredient of Adder's Spear Ointment for snakebites, made by boiling the plants with unsalted butter. The Maidenhair Fern was supposed to stop the loss of hair and make new hair grow on a bald head. Other ferns were used to heal wounds; mend bones; and cure asthma, colic, jaundice, and mild fevers.

KE FERN
(M
JM)



MAIDEN FERN
(ADIANTUM PEDATUM)

TRICHOMANES

POLYPODY

(POLYPODA COMUALE)

ADDER'S-TONGUE

(ADIANTUM PEDATUM)

WALL RUE

(ASPENIUM RUTAMURARIA)

Of course, scientists have disproved these strange beliefs. It is now known that there is nothing mysterious about ferns. They are, however, lovely to see and interesting to study.

Ferns today have some practical uses.

What are some practical uses of ferns?

In South America, the trunks of several kinds of Tree Ferns are used as timber

for making telephone poles and for building. They stand up well, resist decay, and are free from termite attacks. In Hawaii, cushions and mattresses are stuffed with the silky hair-like fibers of certain ferns.

The stem and roots of the Male Fern were once used in place of hops in brewing drinks, and its ashes for making glass. Fresh Brackens contain tannic acid, which is employed in preparing leather; they have also served as fish and fruit packing. In Scotland, such plants were burned while green, and the ashes were made into balls that took the place of soap. Their leaves have been used for burning limestone. Houses have been thatched with such leaves,

and in many parts of the world, they are cut as bedding for animals.

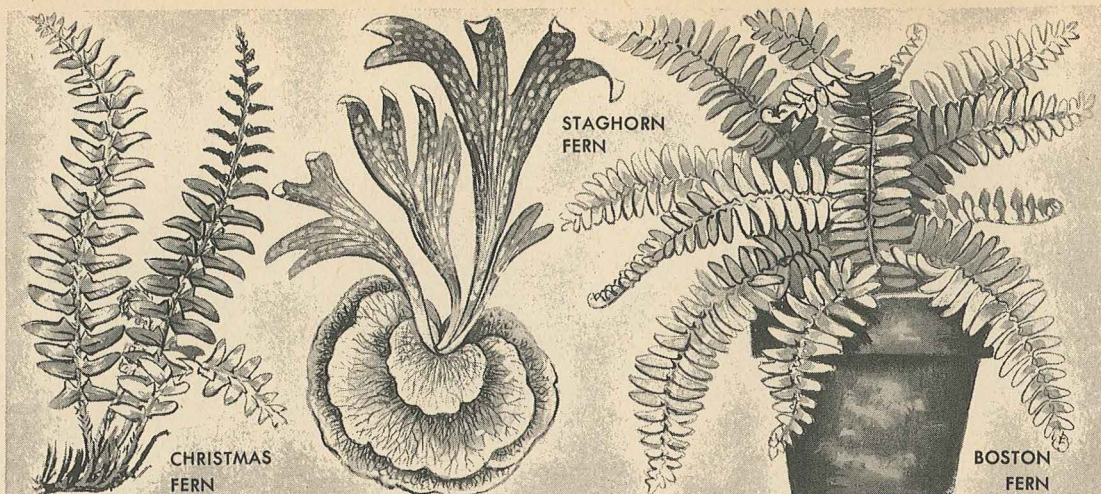
Some ferns have food value. The rootstock of the Shield Fern is eaten by Alaskan Indians. They like its sweet, smoky, tobacco-like flavor when it has been baked in pits lined with hot rocks. The *Osmunda* are tender, crisp, and edible, and taste like raw cabbage. Young ferns are sometimes cooked and eaten like asparagus. The leaves of the Ostrich Fern taste like spinach. The Hart's-tongue tastes like glue, but in France, it is added to milk as a flavoring. In New Zealand, *Pteris Esculenta* is called Bread-Root and is a common article of food.

Some ferns found on rocks, such as the

How do ferns look and smell?

Trichomanes genera, are so tiny and moss-like that an

entire plant is only as large as a fingertip. The fragile Wall Rue, which has leaves several inches long, hides in rock crevices. The luxuriant Tree Ferns, which often grow as high as fifty feet in the rain belt, are just as abundant and even bigger than they were in the Coal



Boston Fern (*Nephrolepis*), Christmas Fern (*Polystichum acrostichoides*), and Staghorn (*Platycerium*) are cultivated for their beauty. The Staghorn Fern, native to tropical Africa, grows on pieces of tree trunk and makes a beautiful ornamental plant.

Age. They still form extensive forests where they tower on tall rootstocks several inches in diameter, which are really modified tree trunks. Their crowns are great clusters of fertile leaves from fifteen to a hundred feet long.

Ferns grow profusely, too, in the more northern regions; but they are not so varied because the cold winter season interrupts their growth regularly. Most of the northern ferns are rooted in the ground, while many in the tropical forests are found on trees. Several species are found floating on the still waters and estuaries of tropical seas. Some ferns are herb-like; others resemble shrubs. There are creeping ferns, perching plants, and climbers like the Climbing Ferns. The interesting Walking Fern has dark green leathery fronds, which bend over and touch the earth to root and form new plants. The new plants, in turn, grow up and repeat the "walking" process.

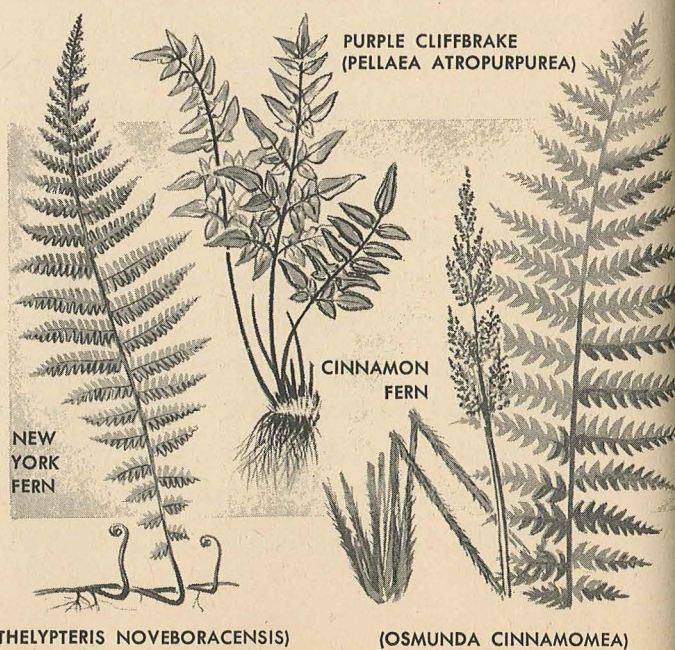
Usually, ferns are bright green. Some, however, are light golden green. The fronds of the Cinnamon Fern are, as you guessed, cinnamon-colored. The fronds of the Interrupted Fern are dark ash green and appear almost black. The leathery leaflets of the Purple Cliffbrake are bright blue green, and its stalks are

purple. As the fronds of some ferns mature, they appear silver gray or red. The smooth, shiny Sensitive Fern has wine red leaves which fade to green as the plant matures. The hardy Christmas Fern remains green throughout the year.

Some ferns are aromatic and scent the air. The New York Fern has a lemon- or vanilla-like odor. The Fragrant Fern smells like new-mown hay, primroses, strawberries, or raspberries.

If you visit a botanical garden or private greenhouse, you will see many attractive ferns.

The Sword Fern, which is a native of Florida and the tropics, became a com-



(THELYPTERIS NOVEBORACENSIS)

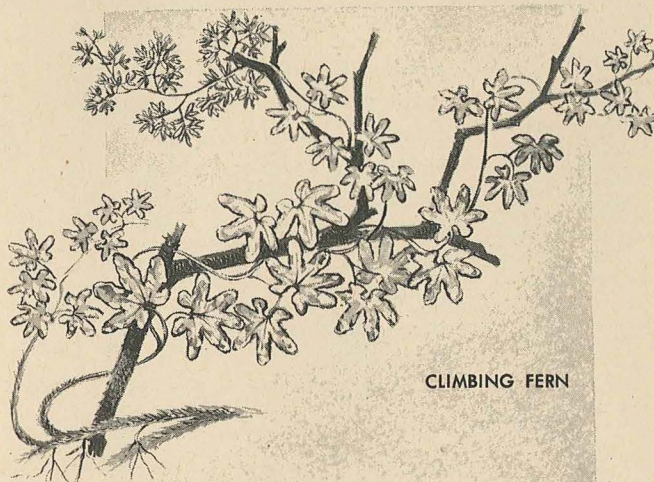
(OSMUNDA CINNAMOMEA)

(Nephro-
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Fern, na-
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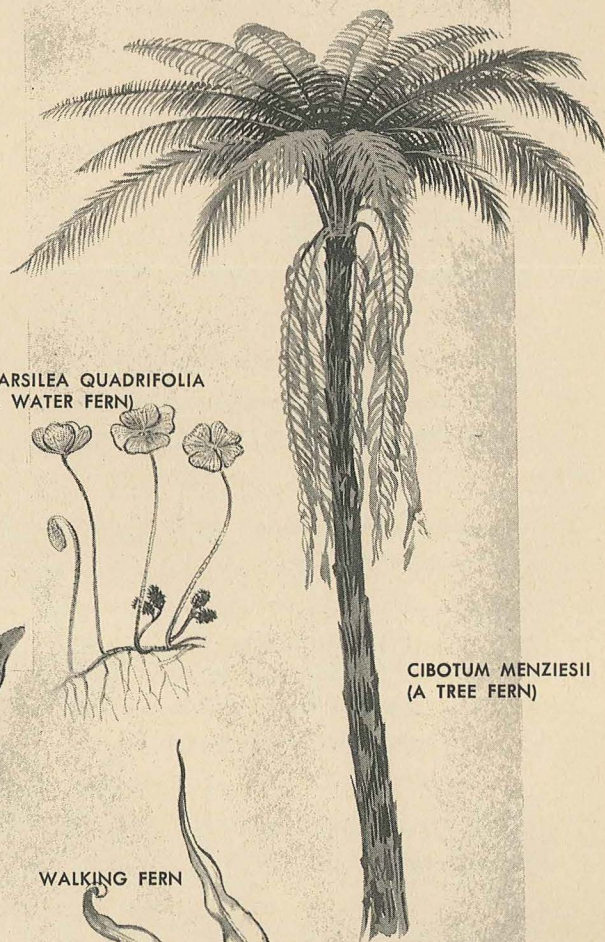
mon greenhouse variety with a new name as early as 1793 when a Boston florist found, among his plants, some that had more numerous and graceful leaves. He called them Boston Ferns, and millions have been sold all over the United States. In the northeastern part of the country, great quantities of the Christmas Fern and common wood ferns are gathered in the fall and put in cold storage. They remain there until needed by florists for bouquets and floral pieces. Ferns are often grown in gardens for extra beauty. Delicately lacy or coarse, but always graceful, their lovely green makes a perfect back-drop for more colorful plants.

Ferns have an alternation of generations. The young fern does not resemble the parent plant, but their young resembles the "grandparent." An asexual plant, the sporophyte, alternates with a sexual one, the gametophyte generation. On the lower side of a fertile fern (sporophyte generation), tiny green specks appear. Soon, these dots turn dark brown. They have a white covering to protect them while

young. Each dot is really a mass of tiny, nearly globular spore-cases made of a layer of skin fastened to the frond by little stems. These capsules contain many cells, or spores. When the spores

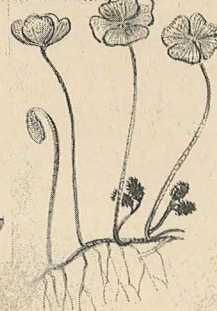


CLIMBING FERN

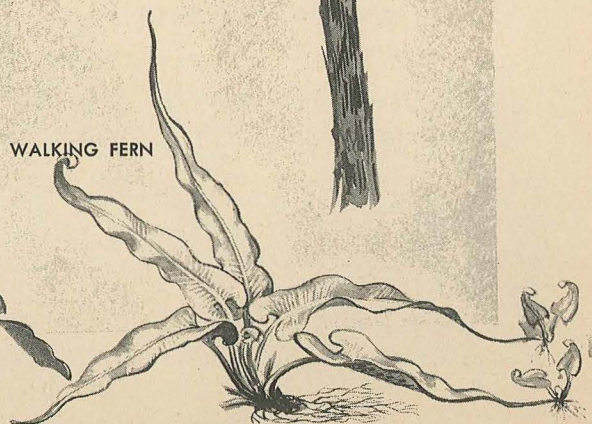


CIBOTUM MENZIESII
(A TREE FERN)

MARSILEA QUADRIFOLIA
(A WATER FERN)

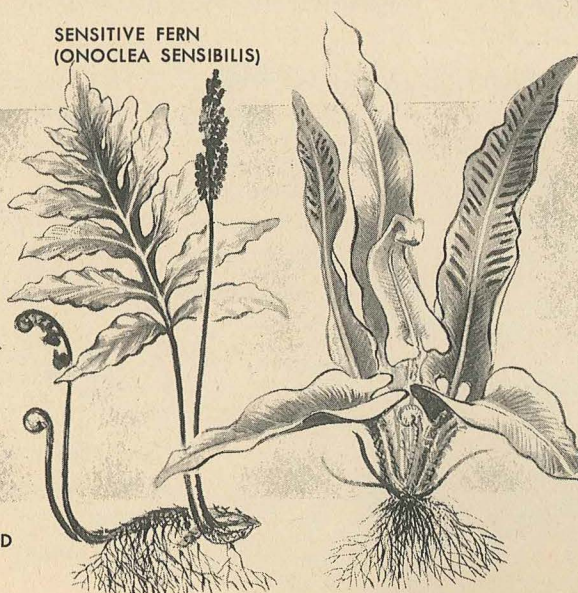


WALKING FERN

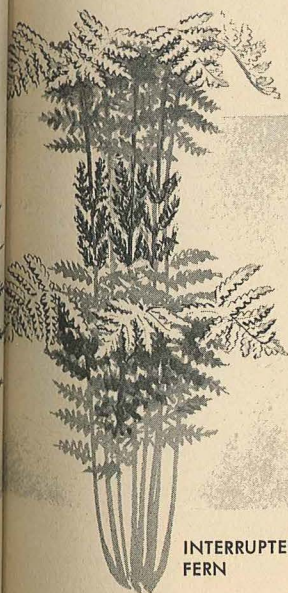


(CAMPTOSORUS RHIZOPHYLLUS)

SENSITIVE FERN
(ONOCLEA SENSIBILIS)



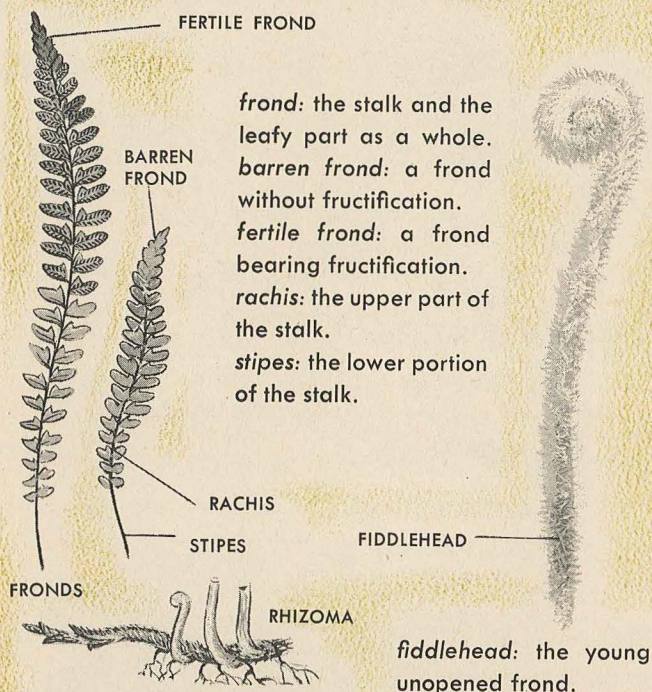
HART'S-TONGUE FERN



INTERRUPTED FERN

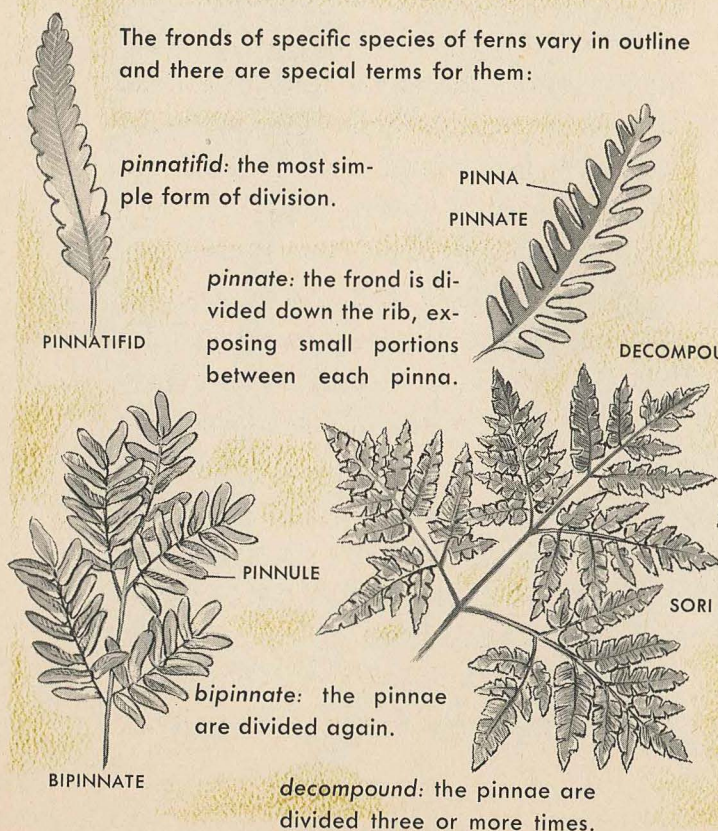
(OSMUNDA CLAYTONIANA)

There are some special terms used in the description of the structure of ferns which, since you are interested in the subject, are worthwhile to remember. We will give you a little "illustrated dictionary" of them:



rhizoma: the true stem of the fern, resembling a root, and therefore also referred to as the rootstock.

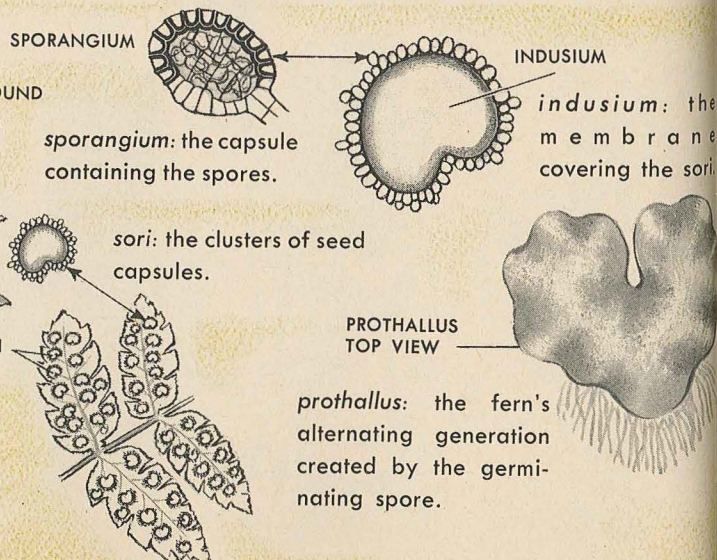
The fronds of specific species of ferns vary in outline and there are special terms for them:



are ripe, a jointed ring of elastic heavily-walled cells extending around the spore-case opens with a snap. The spores are then discharged into the air and the wind scatters them about.

A single spore is an atom of fern substance so small it cannot be seen without a microscope. This minute, dust-like grain has a hard outside layer. When it drops in a place that has the right amount of moisture and warmth, this plant cell begins to swell and after a few days, breaks its coat. This living one-celled structure divides and makes two cells. Each one of these, in turn, divides to make more cells. A thread of cells develops eventually. This cell multiplication by division continues until, finally, a small plant is formed.

As the spore sprouts, it emerges as a delicate green tube, changes to a club-shaped form, and finally becomes a curious flat, green, leaf-like body, the prothallus. About a quarter of an inch across, the thin, heart-shaped mass is unfernlike in appearance. This small object is attached by many root-like strands, on its lower side, to the soil, from which it gets its nourishment. On its under-surface, among the root hairs,

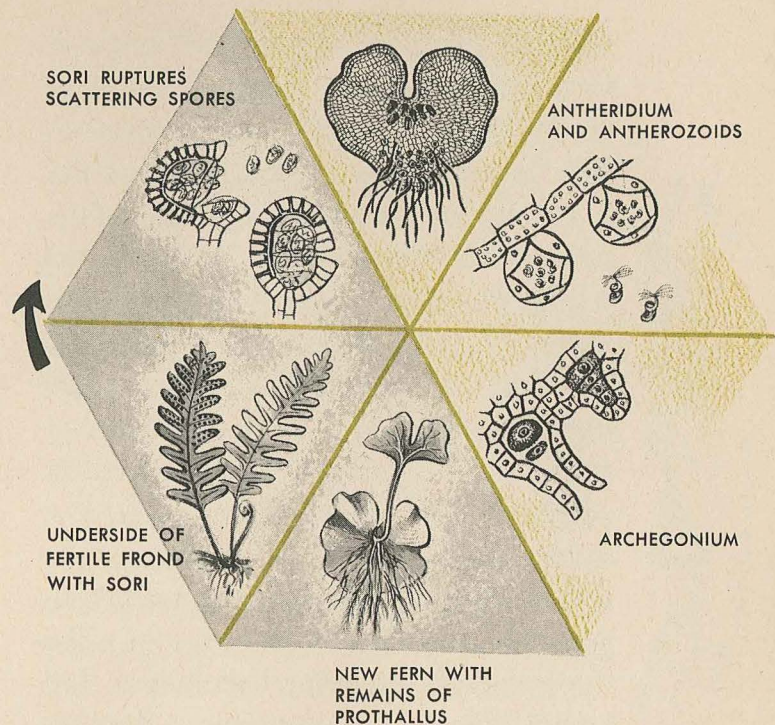


it bears two kinds of sex organs for the production of a new plant. This stage of the fern is known as the gametophyte generation.

The round male organs which produce several tiny movable spirally-coiled cells (sperms), appear first and are found near the edge of the prothallus. The long, pocket-like female organs, which produce a single specialized egg, are more deeply imbedded in the central region of the prothallus. During a wet period, when the prothallus is covered with a thin film of water, the sperm cells are released, and swim rapidly about until they find their way to the female organ. One enters the neck of the flask-like structure, penetrates the sticky contents of its tube, and unites with the egg to form an asexual spore. The fertilized egg grows into a new fern plant.

The spore slowly divides into four regions — the beginning stem; the first root; the first bud; and the fourth becomes a part that secures nourishment from the prothallus. The new independent spore-bearing plant, really only half of the actual two-stage plant, is called the fern. As soon as the young

SPORES GERMINATE
AND PRODUCE PROTHALLUS



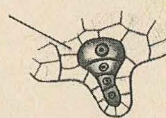
In the life cycle of the fern, the sporophyte generation is the dominant visible one and is our conception of how a fern should look.

plant is well-established and able to obtain food for itself, the prothallus withers and disappears.

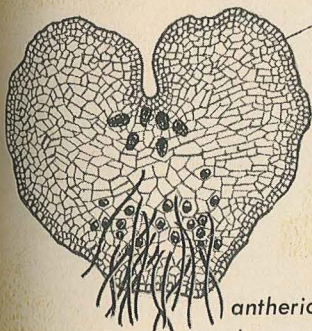
In its early stages, the fern looks like a brown-green, tightly-packed ball on the ground. The buds are spiral and the fronds are whole, with even the fruiting organs. They have many bright golden scales, which are silky at first and turn papery later. These scales provide a warm covering and remain on the stalks and blades. Although this blanket does not keep the plant at a higher temperature, it prevents loss of vapor, a cooling process. In this way, the plant is protected against cold and dampness.

The young golden brown, wooly fronds grow from their stout ascending rootstock in buds coiled like watch springs. Each part is rolled in on itself,

archegonium: the female part of the prothallus; it corresponds to the ovaries in flowering plants.

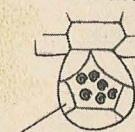


PROTHALLUS
UNDERSIDE



antherozoids: the minute bodies set free by the antheridium.

ANTHEROZOIDS



antheridium: the masculine part of the prothallus; it corresponds to the anthers in a flowering plant.



with the tip in the center of the spiral. Continuing to grow, the plant stretches up from the ground and appears to lean backward on its stout brittle stalk. Beginning at the tip, all the small divisions of each frond roll down to the crown. First, the main stem loosens its tight coil, but before it is completely unrolled, the smaller leaves, which are tightly coiled at right angles to the main stem, begin to unfold. Then the tiniest of the leaflets, at right angles to the small, unroll. This unfolding may take several days. By late summer, each "fiddlehead," so called because it looks like the head of a violin, becomes a full frond. When the plant matures, dots appear on the fruiting fronds, and this plant becomes a parent to start the life cycle all over again. The fronds wither and die, but new ones grow to take their places.

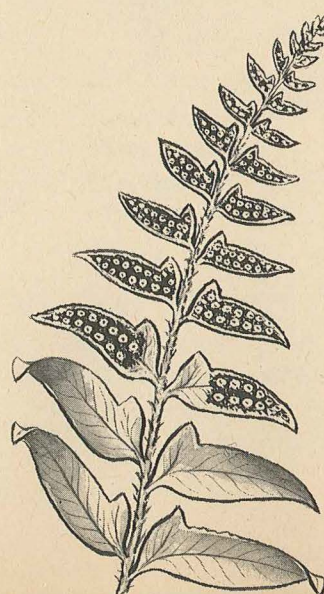
The fruit-dots of ferns are yellow, orange, or brown. In some ferns, they are so large that they almost cover the leaves on which they are found; in others, so small that they can hardly be seen. You can study them on the back of a leaf with a lens. The open globules are the spore-cases, each packed with spores. Most plants have their fruit-dots in little groups arranged usually in a pattern along the back of the frond, but sometimes, along the edges or on the upper side. Some ferns, such as the Walking Fern, have them scattered over their fronds without order, some parallel to the midrib, others oblique to it. Sometimes, they are found on special fronds, and occasion-

Are all fruit-dots alike?

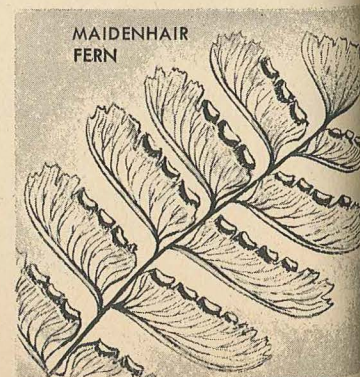
ally, as in the Interrupted Fern, they are seen on special parts of a frond. If you find such a fern, you will see that its leaflets look withered and brown. You will discover, however, that they are not withered at all, but have changed into little cups to hold the spore-cases. If you can get a Christmas Fern, scrape a little of the brown fuzz from its fruiting leaflets on a glass slide and place a cover glass upon it. Look through a microscope to find the spore-cases and see the spores plainly.

Each fruit-dot contains a definite number of yellow-, green-, or brown-colored spores, in different shades but always even in number, forty-eight to sixty-four. If you use a powerful microscope, you can study a single spore. The asexual spores produced are a resting stage in the life of a fern. Most spores begin to develop at shedding, but some may live for as long as twenty years before developing. A single plant may produce as many as 50 million spores each season for many years, and yet the species may not be abundant, as it is difficult for a new

How many spores does a fern produce?



CHRISTMAS FERN



MAIDENHAIR FERN

HART'S
FERN

fern to become established. Some, such as the Cinnamon Fern, bear spores twice a year. Most spores are scattered when ripe, but the spore-cases of the Sensitive Fern stay sealed all winter; the spores are not released until the following spring. Only a very few spores ever mature, for nature's plan of balance prevents the growth of too many. Extremely lightweight, they may drift for long distances in the air before coming to rest in a place suitable for their development. Some travel as far as 10,000 miles away from the parent plants.

A fern needs from three to seven years to become a mature, reproductive plant. Because so much danger threatens the young sporelings during this time, many may never reach their full growth. However, they have a number of methods of reproduction, and devise ways of avoiding peril. The Brackens produce new plants all along their branching rootstocks; these woody rootstocks, deep in the ground, are protected against dryness and cold.

The Bladder Fern produces not only a great number of spores, but also grows

little bulblets on the under-surface of its fronds. Many of its spores may never find a good place to start growing, but the fleshy bulblets drop into the soil around the parent plant and sprout roots and leaves. New plants form to continue the species. The first fronds of the bulblets are much more mature than those from the prothallus and will produce spores much sooner, as they start life practically grown-up.

There are some ferns that send out slender shoots which form new plants at their tips. In the Walking Fern, the narrow, triangular fronds arch over and root at the tips to grow new ones. Other ferns produce tubers on their roots, and these become plants. A tropical species has both tubers and shoots.

Almost all ferns are perennial, growing year after year. Some live for centuries; fresh fronds replace those that die. In the autumn, new buds are produced on the growing tip. These and the stem give rise to plants the following spring. As the stem stretches, the old parts of the plant waste away. Since most ferns are rather delicate, their individual fronds seldom last more

How long does a fern need to mature?

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How long do ferns live?

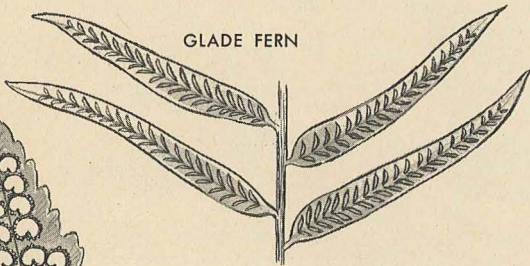
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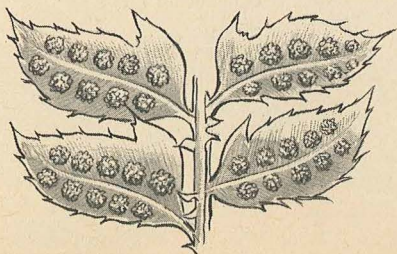
HART'S-TONGUE FERN



GLADE FERN



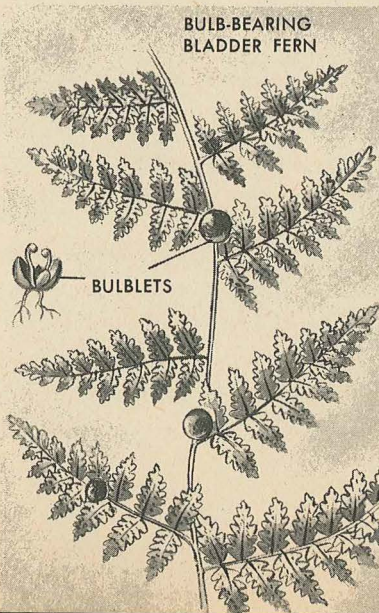
HOLLY FERN



CRESTED FERN



BULB-BEARING BLADDER FERN



The arrangement of the fruit-dots varies in different species of ferns.

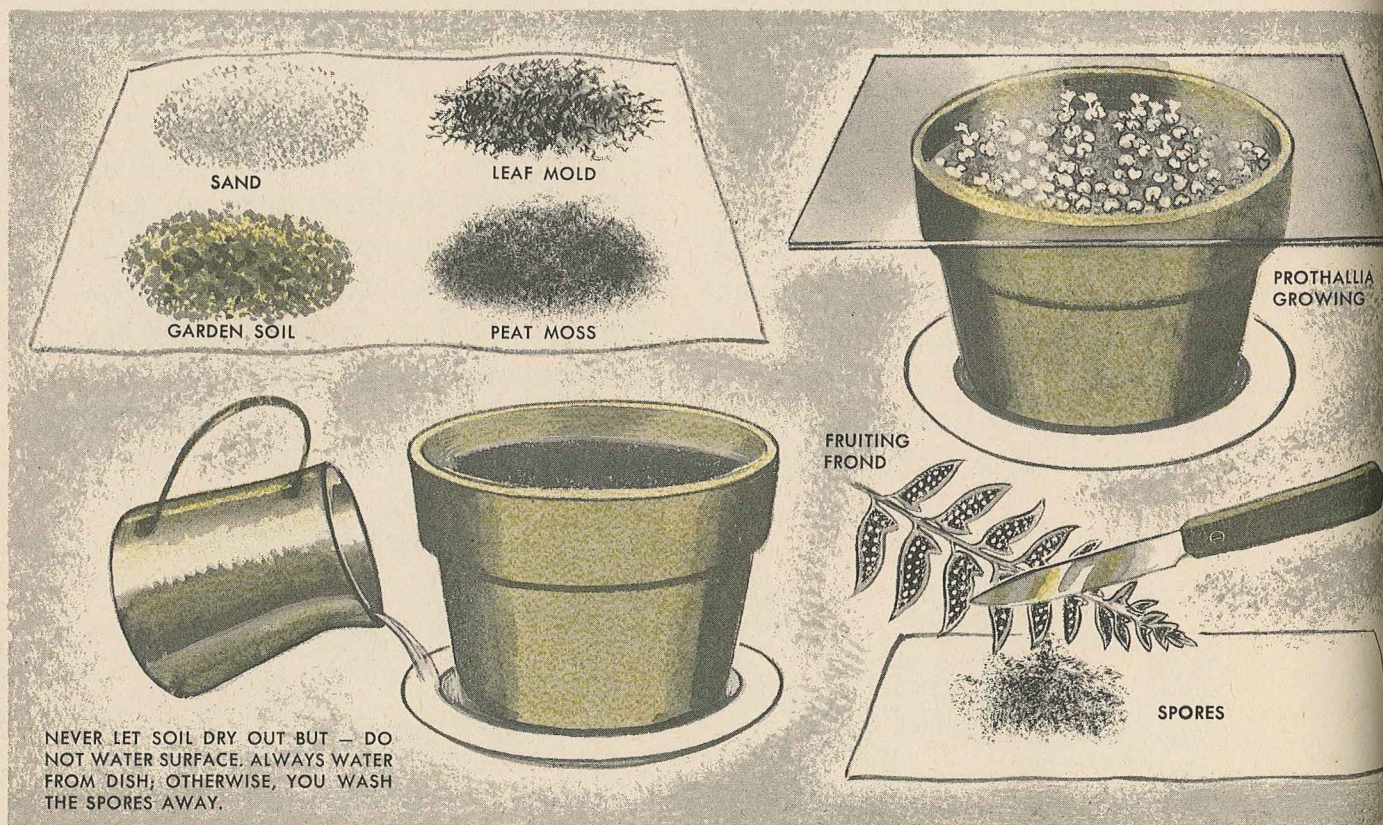
than a year. They turn red, yellow, or brown, and, falling, enrich the soil as fertilizer.

The spores that do live seek different kinds of habitats. Most prefer moisture, moderate temperature, and protection from direct sunlight so that they can reach full growth. However, some, such as the Brackens, brave the sunlight of open fields. In the temperate region, ferns grow in shady woods, swamps, bogs, standing water, rocky ravines, and nooks. Most of them grow on the ground in damp places, but some like dry, shady cliffs. Some, like the Resurrection Fern, which is protected

Where do ferns grow?

by a scaly layer, are found in such dry places that, in a season with little rainfall, their fronds roll up, become brittle, and appear to be dead. When it rains again, they uncoil and take on new life.

Where there is enough moisture and favorable temperature, ferns grow on tree trunks and branches, often many feet above the ground. Some species grow in the shelter of crevices in rocks; others hang from mossy cliffs, sending their roots in all directions to get moisture. Some such plants prefer limestone; others can be found on granite, shale, gneiss, quartzite, or sandstone. If you transplant some ferns, provide them with the same conditions they had in their original habitat.

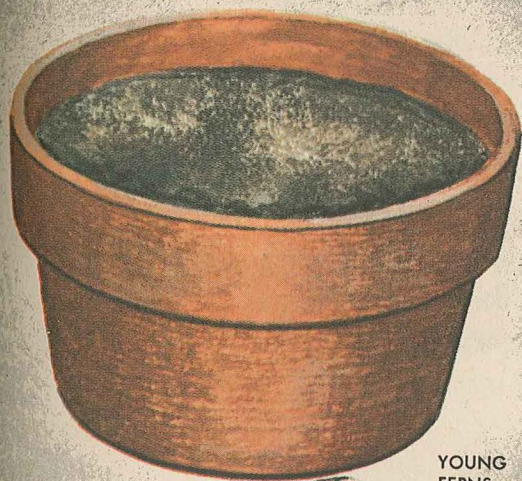
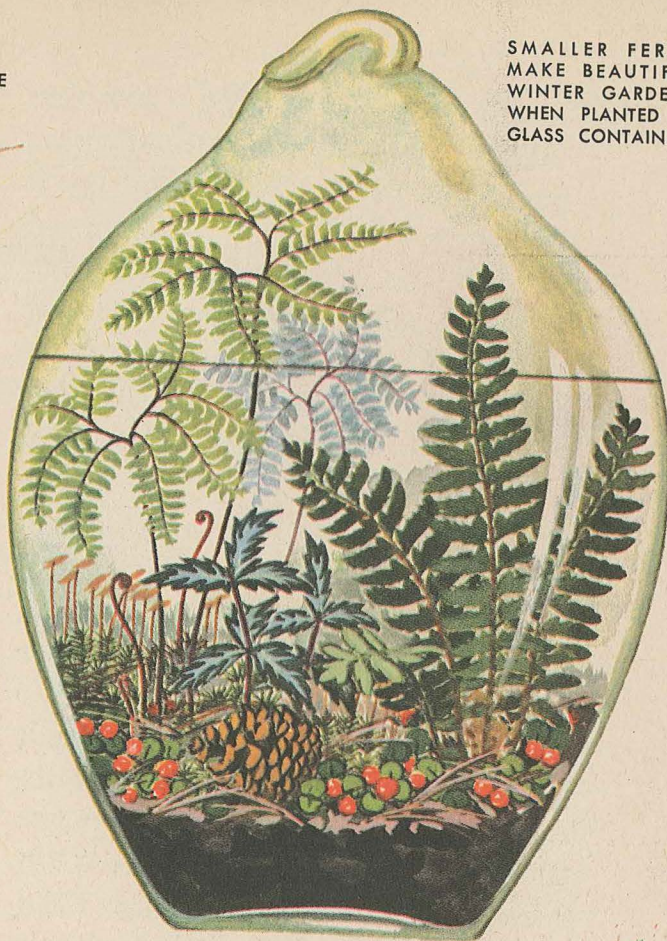


HOW TO GROW A FERN FROM SPORES

CRESTED FERN

GLADE FERN

SMALLER FERNS
MAKE BEAUTIFUL
WINTER GARDENS
WHEN PLANTED IN
GLASS CONTAINERS



YOUNG FERNS



GRAPE FERN

HOLLY FERN



To see a spore pattern, find a fern that is in the fruiting stage and lay it on a sheet of white, fuzzy paper.

How you can make a spore pattern and grow a fern from spores

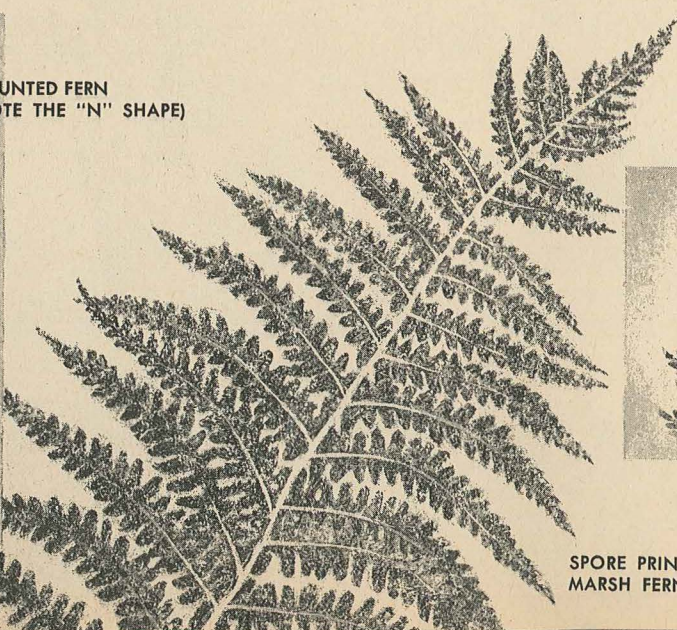
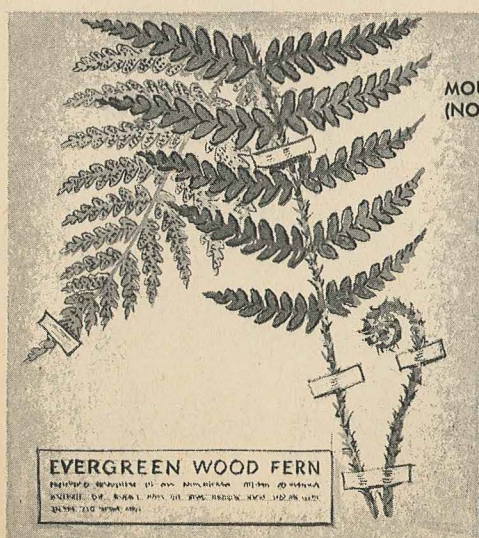
Leave it for a few days where it will not be disturbed and where there is no draft. Pick the fern up carefully and you will see its form, outlined in spore dust, on the paper.

You can reproduce some ferns from spores. Fill a small, clean flowerpot with a mixture of one part each of sand, garden loam, leaf mold, and peat moss. Place this pot with its bottom in a dish of water until it has become thoroughly moistened. In the meantime, tear the fern fruit-dots apart with a sharp needle, catching the spores and the spore-cases on a piece of white paper. Then, dust the spores onto the soil. Cover the pot with a sheet of glass, or place it under a glass jar. Keep the dish filled with water, and set it in a warm, moderately lighted place. The spores should begin to grow a green thread, and the prothallus should appear in about a month. When the plants have made a good start, transplant them into larger pots filled with a combination of sand and leaf mold. Some ferns may require

the addition of lime to the mixture to make the soil alkaline. Any delicate species should be grown under glass. (For illustration, see pages 32-33.)

It is easy to learn to recognize different kinds of ferns. If you want to collect some, wear clothes you can climb around rocks and wade swamps in. Take some digging tools to get a piece of underground stem. More perfect specimens can be grown from your collection, and you may keep rare species from becoming extinct. However, be careful about taking rare species; make sure there is a well-established colony before you remove one.

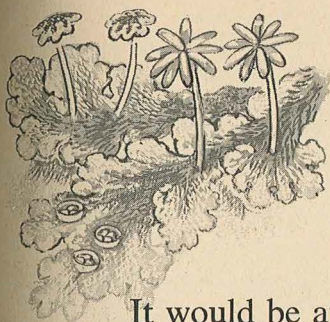
Then, press the ferns in a plant rest. You should change the dryers often. Mount the specimens on herbarium sheets, and note complete information on each label. Break the leaves of large ferns into a "V" or "N" shape before mounting. The habitat; rootstock; veining, color, and cutting of the fronds; the shape, size, and position of the fruit dots; and the presence or absence of a protective covering are identifying characteristics.



SPORE PRINT OF
NORTHERN LADY FERN



SPORE PRINT OF
MARSH FERN



Liverworts and Mosses



It would be an omission if we failed to include some information about the liverworts, first cousin to the mosses. They are, like the mosses, mostly fairly small and are, like the mosses, among the simplest land plants. Both belong to the same group of plants, the *Bryophyta* (from a Greek word used to describe a moss). Both liverworts and mosses, just as the ferns, have an alternation of generations, a sexual generation (gametophyte) alternating with an asexual (sporophyte generation) one. Though often confused with the mosses, the liverworts show distinct differences from them. Their plant body is not differentiated into stem and leaves but consists of a flattened frond (thallus); or, if there are leaves as in the so-called "Scale Mosses," which are actually "Leafy Liverworts," the leaves are divided into segments and have no midrib or nerve. The mosses, on the other hand, have true stems and leaves; the leaves, never lobed or divided, have a midrib.

No species of either of the two has real roots, but their rhizoids (root-stocks) perform the functions of roots, anchoring the plants and taking materials out of the ground to make food.

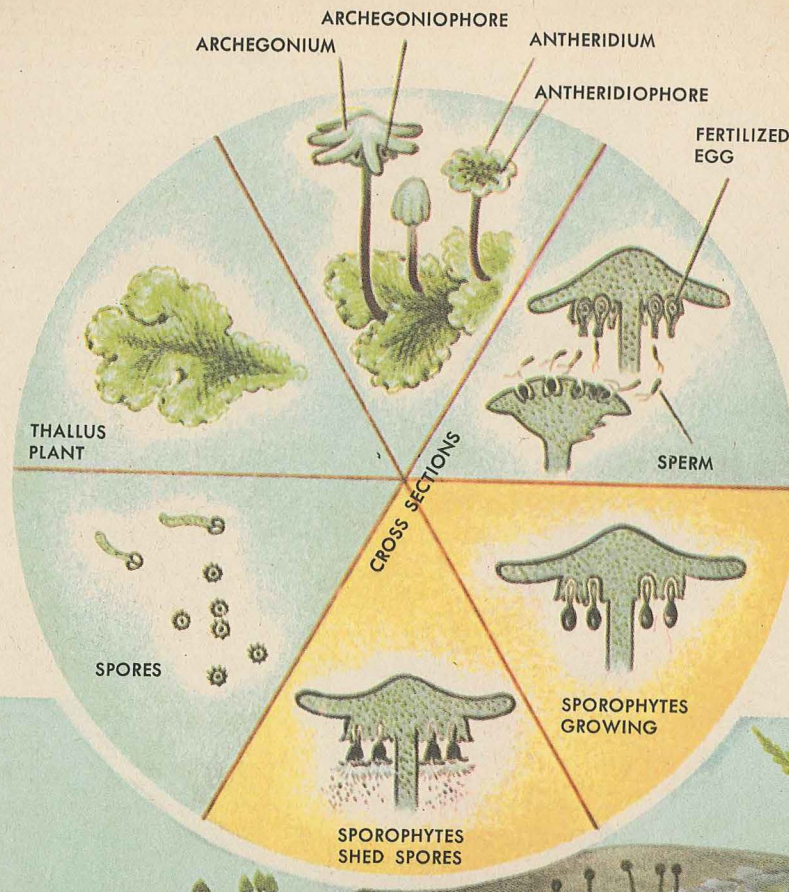
Mosses are found everywhere in the world but deserts. Iceland and Greenland have many species that hibernate under blankets of ice and snow in the long winter months. They live in the

warm Equator lands. Mexico and tropical America are rich in mosses. They can be found on even the rocky slopes of Mt. Everest. The evergreen forests of our West Coast have more, and bigger, mosses than any other part of the continent. Moist, bare, or wooded spots in the tall-grass prairies and short-grass plains have their mosses.

Mosses are fascinating plants that carpet the forest floor in a beautiful green, or decorate logs and boulders with velvety rosettes. Some look like tiny ferns or feathers; others have the appearance of palm or pine trees. They are green and attractive before other plants in the spring and remain so later into the fall. Covering the earth, they lend a rich touch to the landscape. Although a great many look alike, each species has its own style of beauty.

You can lift these plants bodily and transplant them indoors in a terrarium. Collect enough of the substance on which the plants grow so that you will not disturb the rootlets. Be careful to give them enough moisture and not too much sun.

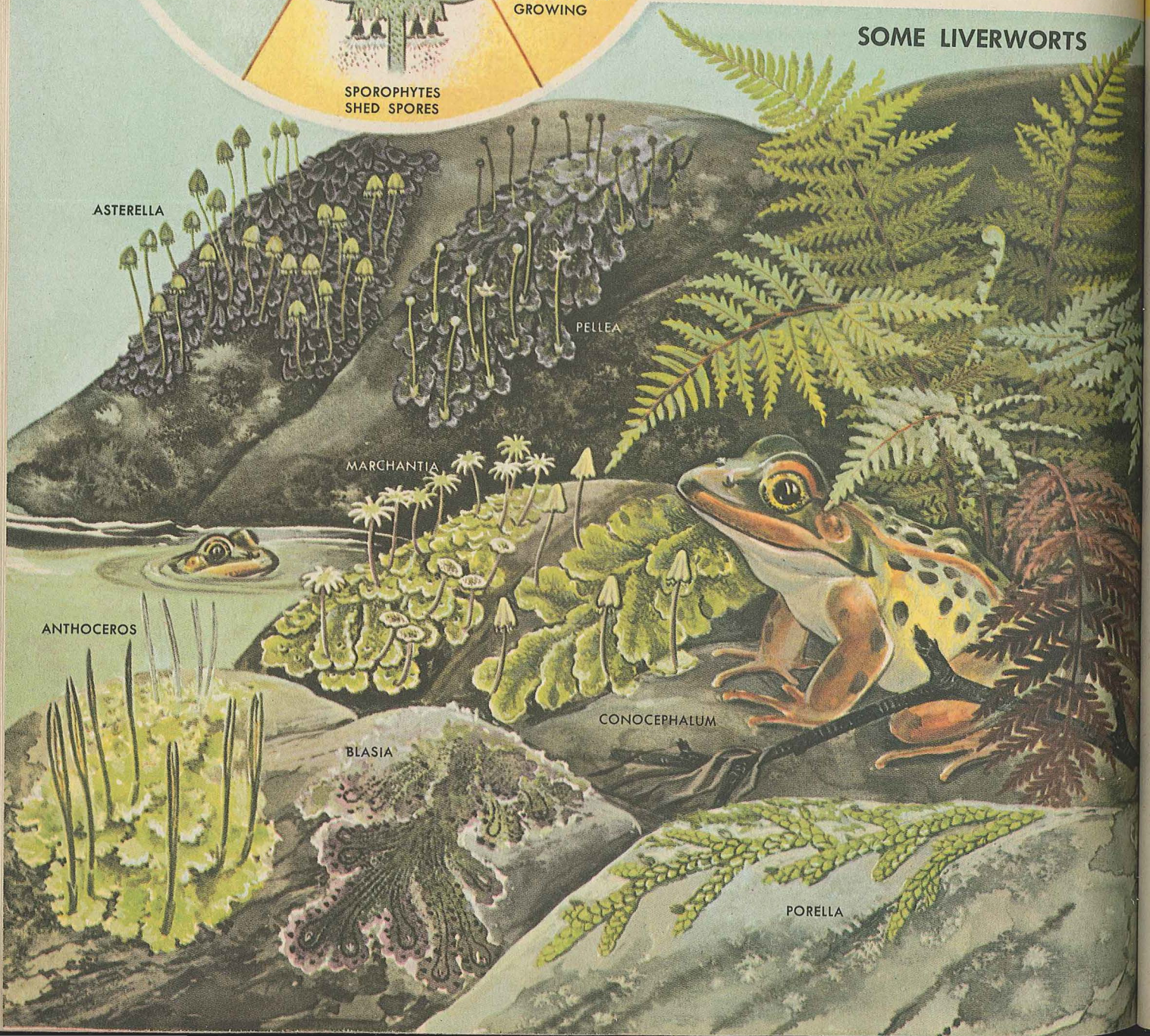
Like the liverworts, mushrooms, and ferns, mosses have scientific or common names, too, and their Latin names tell their order, sub-order, genera, and species. Only the most common kinds have nicknames, such as Pincushion Moss, Fern Moss, Plume Moss, Broom Moss,



LIFE CYCLE OF A LIVERWORT

The sporophyte generation in the life cycle of a liverwort is barely visible. In our illustration, the phases of the sporophyte generation are on the yellow background. The gametophyte generation on the blue background, in our illustration, is what we generally associate with the appearance of a liverwort. The plants were called liverworts, because some larger species were thought to resemble the lobes of the human liver. Below are some of the better known species of liverworts.

SOME LIVERWORTS



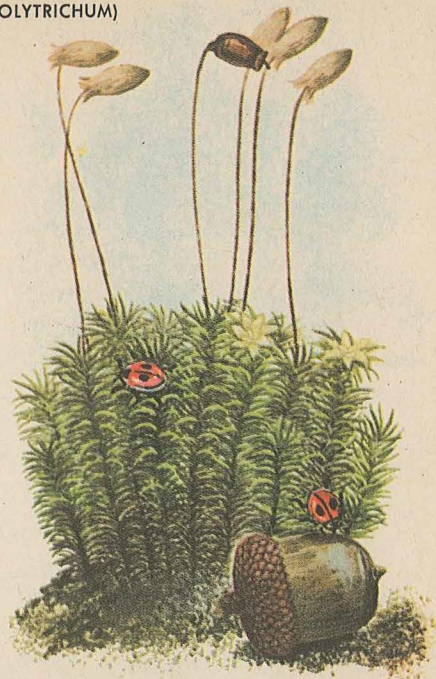


HYPNUM CHRYSOPHYLLUM



COMMON FERN MOSS (THUIDIUM DELICATULUM)

PIGEON WHEAT OR HAIRY-CAP MOSS (POLYTRICHUM)



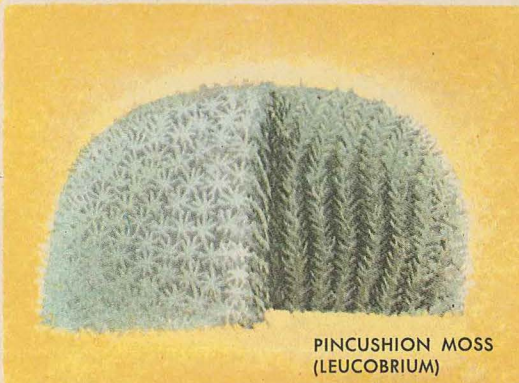
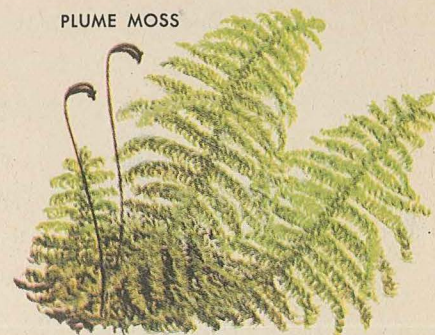
BROOM MOSS (DICRANUM SCOPARIUM)



SMALLER FERN MOSS (THUIDIUM SCITUM)

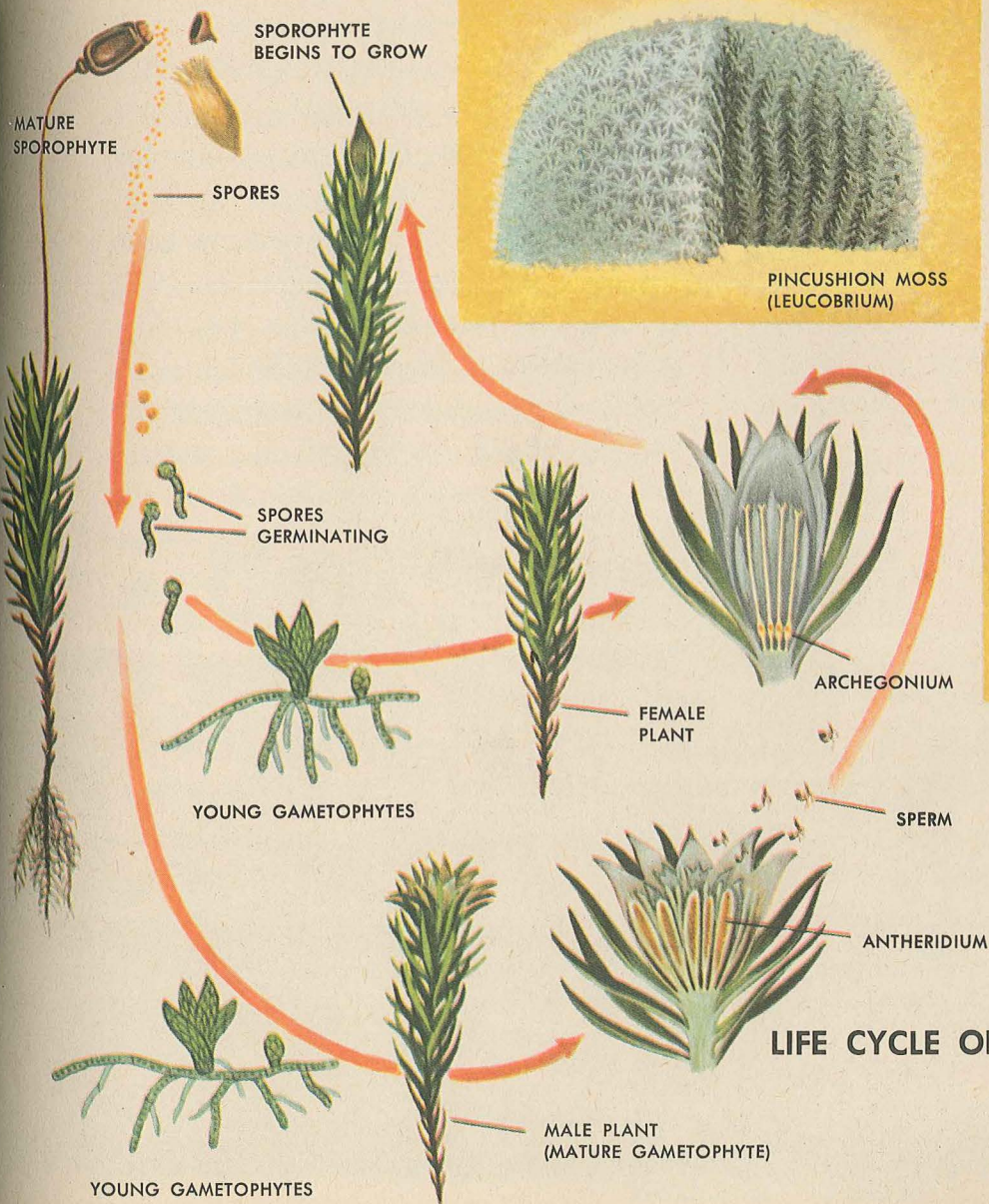
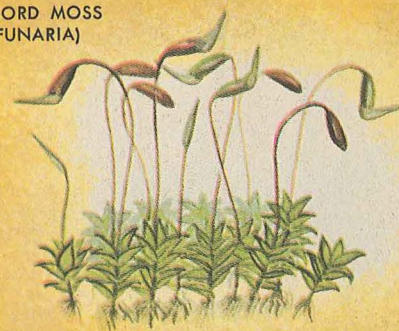
(HYPNUM CRISTA-CASTRENSIS)

PLUME MOSS



PINCUSHION MOSS (LEUCOBRIUM)

CORD MOSS (FUNARIA)



LIFE CYCLE OF MOSSES

and others suggested by some special characteristic.

Although humble members of the plant kingdom, they played a great part in making the land fit for animal habitation. In the beginning, the most primitive plants, the algae and fungi, covered bare rocks and, after dying, provided a small store of good-giving soil. Then, liverworts and mosses made their appearance, completed their life cycle, and formed a richer layer that made the growth of higher plants possible. Next, the mosses, together with the higher plants, formed the food material which nourished all life on land.

In ancient and medieval medicine, mosses had their place in the concoction of cures for a variety of aches and pains. Several scale-like species

What were some old superstitions about mosses?

with bodies marked like a cross section of an animal's liver were thought to cure liver ailments. Golden-hair Mosses were first dedicated to Venus and later to the Virgin Mary. Because these veil-like mosses so resemble a maiden's tresses, they were used to make a wash to strengthen the hair.

We know today that mosses have no medicinal qualities. However, clean sprays of Peat Moss, which is absorbent and acts like a sponge, are sometimes wrapped in cheesecloth, sterilized, and used as packing for wounds.

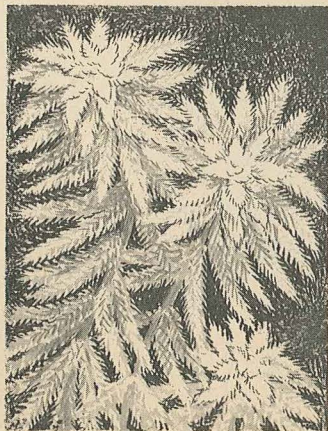
Generally, this group of plants has little practical value, but some kinds have served, and still do serve, in useful ways. Pioneers mixed moss with clay to fill in chinks and cracks in their homes. Dipped in oil, they have been used as lights. The Laplanders use moss for stuffing their pillows. The big long-stemmed plants growing abundantly on the West Coast of the United States are used to pack crockery. Some mosses

How useful are they?

practical value, but some kinds have served, and still do serve, in useful ways.



GOLDEN-HAIR MOSS

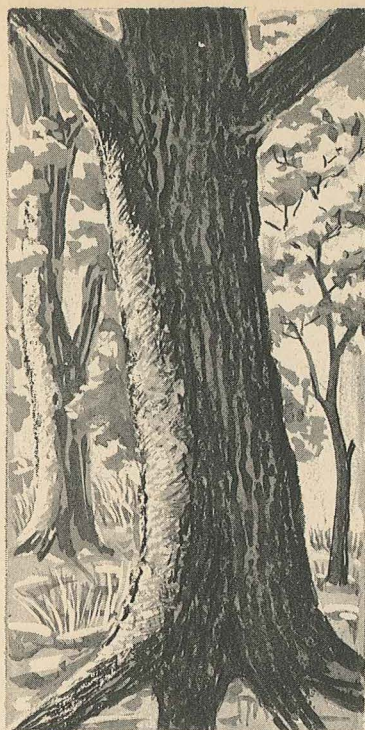


PEAT MOSS
(SPHAGNUM)



Digging for peat which can be used as fuel.

There is an old belief that, if lost in the woods, one can find the direction of north by watching the side of a tree trunk on which moss grows. The statement is wrong in one respect and only partly right in the other. The growths on the trees are usually not moss, but a green algae which grows only approximately on the north side. So be careful with the application of this "tree compass."



furnish food for wild life in winter when other plant foods are scarce, as they are available most of the year. Mosses are sometimes cultivated because of their artistic value in a garden. Sometimes, they are dyed and used for decorative purposes, especially by milliners.

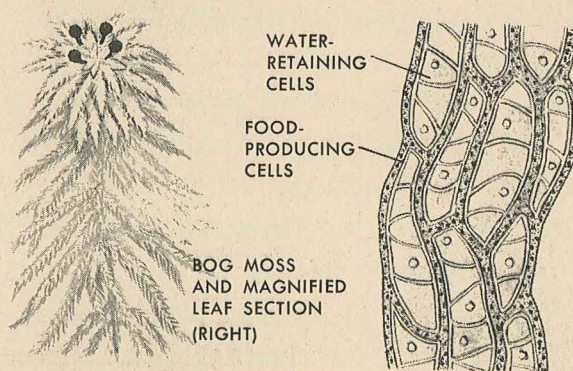
Mosses which make the peat used as fuel in Ireland and Northwestern Europe are the most valuable kinds. Their pale sponge-like leaves, filled with hollow cells, quickly absorb water. The spongy growth fills whole areas in damp meadows, bogs, swamps, or on the shores of lakes or ponds. New plants are continually springing from old shoots so that the top remains growing while the under-layers die. The ones down deeper change into peat. Layers of such moss have accumulated for thousands of years.

Peat Moss is also used by nurseries. Gardeners pack stock in it because it holds moisture and keeps roots fresh during shipment from one place to another. When chopped, this moss makes

an excellent cover for a seed bed, and when added to soil, it keeps it moist and porous.

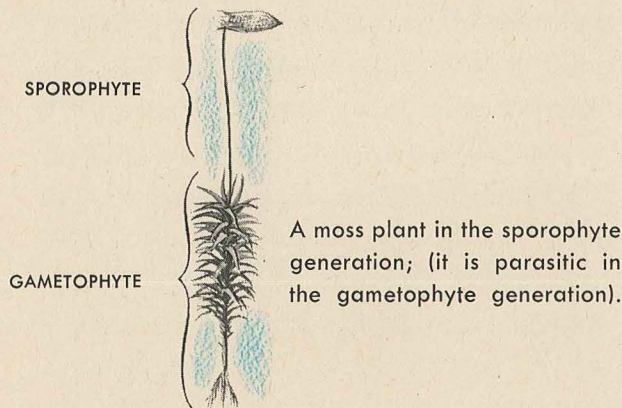
Some mosses have some agricultural worth. It is possible to plan crops by the kinds of moss which grow in certain regions. They show whether soil is acid or alkaline and what, if any, treatment a soil needs to be normal.

Although mosses are of little economic value, they do form part of the natural ground covering. This is important in the formation and conservation of soil. They grow in thin layers of soil on and about rocks. The parts growing underground force their way into minute pores of rocks, making it easier for water and frost to act on them. Small bits of these rocks, dead logs, and our moss plants are steadily forming new soil. Later, this soil will feed larger plants. Moss plants become entangled on the surface of the soil and keep it from water, wind, and weather erosion. Absorbing moisture as they do, they protect plant life by holding back much



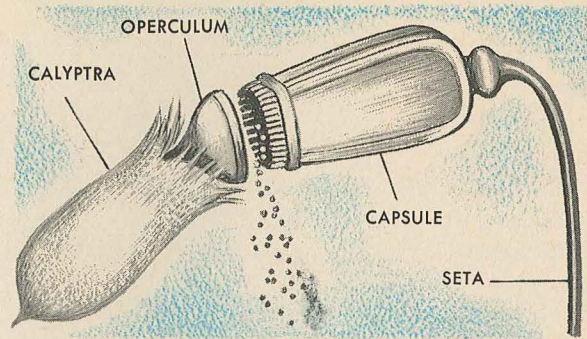
of the rainfall and letting the water soak into the ground gradually. Bog mosses reclaim marshes for higher plants. Those along brooks drink in lime solutions and deposit them where they are useful to man.

The method by which moss reproduces, although curious, is one that we have studied before, for they have an alternation of generations like the fern. (See page 37 for illustration of the life cycle of mosses.) A moss plant resembles a tree with a single straight trunk. Green leaves grow from it here and there all the way from the base to the tip. This leafy part, which bears egg and male cells (sperms), is the sexual, or gametophyte, generation.



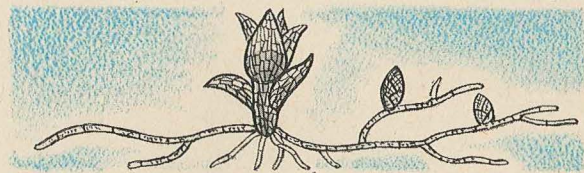
The spore-bearing plant, or sporophyte, which develops when these sperm and egg cells unite, is the asexual generation which can reproduce without the union of two kinds of cells.

Among the upper simple, modified leaves, there appears a thin, stiff, shiny green stalk with a beautiful, knob-like, four-sided fruit the size of a wheat grain at its end. The stem soon turns brown. The fruit, on its attractive little pedestal, is protectively covered by a curved hairy cap with a golden peak, which closes loosely and downily around the stem below. Its walls contain many tiny green one-celled spores. These simple cells are so small that they cannot be seen without a microscope.

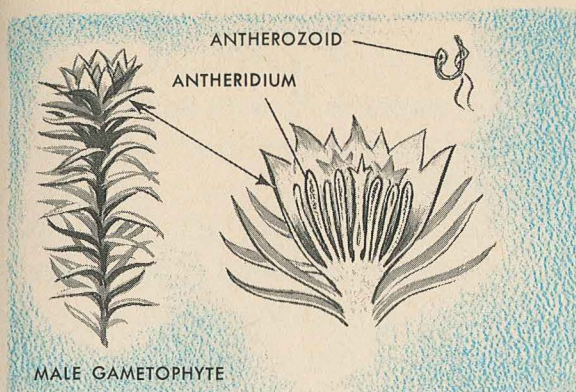


Fruit (capsule) on green stalk (seta) with hairy cap (calyptra) and lid (operculum).

The stem bends to a horizontal position when the spores are ready for discharge, and their thin-walled, cylindrical, ripe spore-case wrinkles. When the hairy veil falls off, the spore-case is shut tightly by a round lid with a point in its center and edges that fit closely about its rim. When the lid is thrown off, sixty-four blunt teeth, bent back and bearing at their tips a thin membranous disk, close the case. In rainy weather, these teeth and the inner cover swell so that not a single spore can be shaken out. When the weather is dry, the teeth change to make a ring of openings between them and the disk's edge, through which the spores pass. When they fall out, the wind scatters them far and wide. Many find room to grow. To develop, a spore must fall in a moist, shady place to grow. It contains enough stored-up food for a baby plant to live on until it can manufacture its own. It swells with water, bursts its shell, and grows into a green thread-like branching, trailing mass. Some partitions in



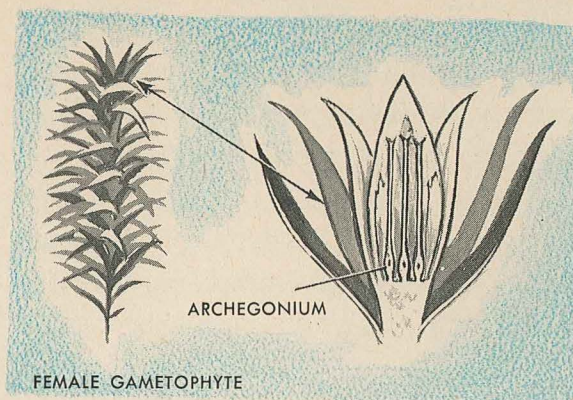
Thread-like mass (protonema) with buds (gemmae).



the thread are oblique; some branches descend into the ground.

Some cells produce buds from which the true leafy moss plant with tiny stalks and slender leaves grows. The outermost cells of the bud form the leaves; the central, the stem; and those at the base, the root-like threads. Some threads contain leaf-green (chlorophyll) and extend over the earth as a fine green web. They hold the plant in the soil and nourish and water it. In the center of the moss stem, there are elongated fibrous cells which conduct water absorbed by the threads to leaves and other parts. When the plant is grown, they disappear.

At the tips of certain shoots and partly enclosed by leaves, are the plant's reproductive organs. The yellowish star-shaped, flower-like cups, one below the other, with stems spanning the middle, are male plants. Plants with pointed narrow leaves are females. Eggs rest inside overlapping leaves. Female sacs are flask-shaped; the male, club-formed. The egg cell is produced near the female sac's base. Many spiral-shaped sperm cells are formed in the male sacs. In moisture, these tiny colorless corkscrew bodies are freed to move through the water by wriggling two

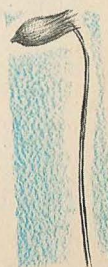


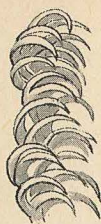
little hair-like appendages. They can swim about in a dew drop, rain, or melting snow for an hour or so.

When the egg is ready for fertilization, the neck of the female sac becomes like a tube of mucilage. The lid opens and oozes out a sticky sweet substance. This attracts the sperms, and they dash into the neck of the female sac. One reaches and fertilizes the egg cell. The double cell remains in the sac while it divides from two into many cells until it is a complete mass of tissues, the fruit of the moss. The fertilized egg does not grow into a green, leafy moss. Instead, it produces a wiry stem with a spore-case at its tip. The wall of the female sac is torn away at the base and carried up as a veil on the growing tissue mass.

This sort of plant takes root right in top of the one that developed the egg. This new spore-producing plant has a little leaf-green which combines with elements in the earth, air, and sunlight to manufacture sugar for food. Because the plant is green for only a short time, it cannot continue to make its own food. It then lives as a parasite, getting its nourishment from the mother plant.

The brown leaves on the lower part of the stem die. The living green ones, set thickly on the upper part, are long,





narrow, and sharp, but thick and grooved, with sharp-toothed edges. During hot, dry weather, they shut up lengthwise close to the stem and twist into a thread to keep their soft green surface from losing moisture. When it rains, they straighten and curve their tips downward.

After the moss is full-grown, its minute spores are freed to float through the air. Scattered by the winds, each one that falls in a good place for growth begins the life cycle all over again.

Mosses are generally small plants. They rarely grow as high as even six inches. **How and where do they grow?** Their many branches are usually cylindrical. Most have regularly attached stems and leaves.

Each species grows in its own environment. Most mosses live on land, the majority of them among trees. They never grow in sea water, only in fresh. A few are found under water in streams and ponds.

Some mosses make their homes on live trees. The Plume Moss grows in cool, damp shady woods. Some species are found on old rotting logs in swamps. Others live on soil-covered, wet, or bare rocks. They sometimes cover wet boulders or dripping cliffs, and make nearby ravines and gorges look green.

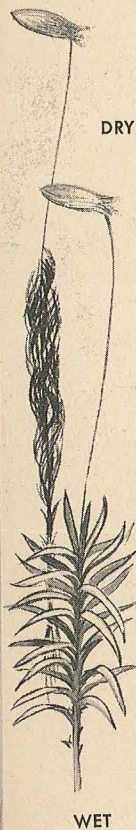
They live on crumbling roofs, old wooden buckets, and brick or stone buildings. Some kinds are found in the sunshine in dry, open places such as fields, meadows, or pebbly soil. They can be seen on sand or boulders along the seashore. Look along roadsides, in

the crevices of city pavements, or right in your own yard. Certain mosses grow at low altitudes; others thrive at heights of 14,000 feet.

Mosses can endure all kinds of weather and can be found under a blanket of snow in the winter, as well as in the summer. However, they must have water so that the leaf-green can manufacture food in the way that we have described and so that the male cells can swim to the egg cells. They cannot store water in their roots or trunks. When the weather isn't right, they stop growing. Instead of facing the sun, their leaves fold or curl up to retain water.

They also need some kind of protection for the chlorophyll grains, which dry up in bright sunlight. The light must not be too weak or the leaf-green will turn yellow and useless, but it must not be too strong or it will be destroyed; the water in the plant will evaporate too fast and the plant will die. Mosses can transfer their delicate leaf-green from an over-exposed to an under-exposed part of the plant or surround the chlorophyll-bearing cells by a wall of large colorless ones. In suitable weather, plants that stopped growing and turned gray or brown because their green coloring matter is hidden, straighten up again, their leaves green once more.

Get some moss plants and let them dry. Drop them into a glass of water and watch the miraculous changes in the leaves as they move. Examine some dried and wet moss with a lens. Observe the difference between the folded and twisted leaves close to the stem of the dry moss and the full, spreading leaves of the dampened moss.



Peat Moss grows in damp meadows, swamps, bogs, and marshes in cooler parts of the country. Such plants are generally found in shallow ponds and "kettle holes," created when the ice retreated after the Glacial Age. As the plants, with their pale, glistening pointed leaves, die, new ones grow and form a springy mat several feet thick and strong enough to support a man's weight. This quaking bog fills up with dead plants until the pond turns to land rich in a black, spongy soil. Tightly pressed, it can be cut into blocks and dried for peat fuel. Because the stems in the floppy-stemmed plants are so large, they can soak up great quantities of water. In fact, they can hold as much as 200 times their own weight. If you can get some Peat Moss, dip it in water and then squeeze it like a sponge. See how long it stays moist. Also, dry some and try to burn it.

The simple leaves consist of a single layer of cells except at the midrib or the thick margin of the leaf. They vary in size, shape, color, texture, and arrangement. They are thin and flat; broad or narrow; thread-like or round. The margins are unbroken; toothed; or bordered with a dark green thick line of cells different from those within. They are never lobed or deeply cut. They can be flat, rolled upward or backward, or turned over. Long leaves measure a half-inch; others are too small or too closely folded to be seen easily without a lens.

They usually grow all around stem and branches and sometimes overlap

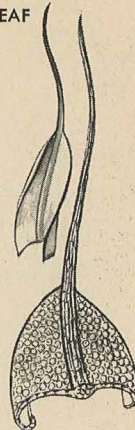
them and hide the leaf's shape. The leaves stop abruptly at the stem in some plants; the edges of others continue down the stem like wings. The cells at the base of the leaves in some plants are just like others or they are sometimes swollen, transparent, or an inflated golden brown. The long slender leaves of the Broom Moss turn to one side and make the plant look like a worn broom. The Wavy Moss has slender leaves that curl when dry. The Plume Moss resembles a great ostrich feather. The Fern Moss, as you would suspect, looks like a miniature fern. To study the leaves of any moss, moisten them and hold them up to the light so that they spread out.

The leaves of some mosses have a single midrib; others, a double one; and a few have none. The single midrib may stop at the middle of the leaf or extend beyond the leaf as a bristle. It may be forked, slender, or wide. Their cells, which can be elongated and six-sided, or spindle-shaped, have various diameters. Some cells are smooth; others have hair-like projections. You can see the midrib if you hold a large leaf to the light.

The stems are of various lengths, or entirely lacking. They may be many-branched, slightly branched, or not branched at all. Sometimes, the main stem is creeping and the others erect or ascending.

Mosses bear different kinds of capsules on yellowish or reddish fruit stalks. They are straight, curved, nod-

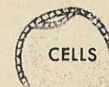
MOSS LEAF



TIP OF LEAF ENLARGED



MIDRIB



CELLS

CROSS SECTION OF LEAF



DRY

WET

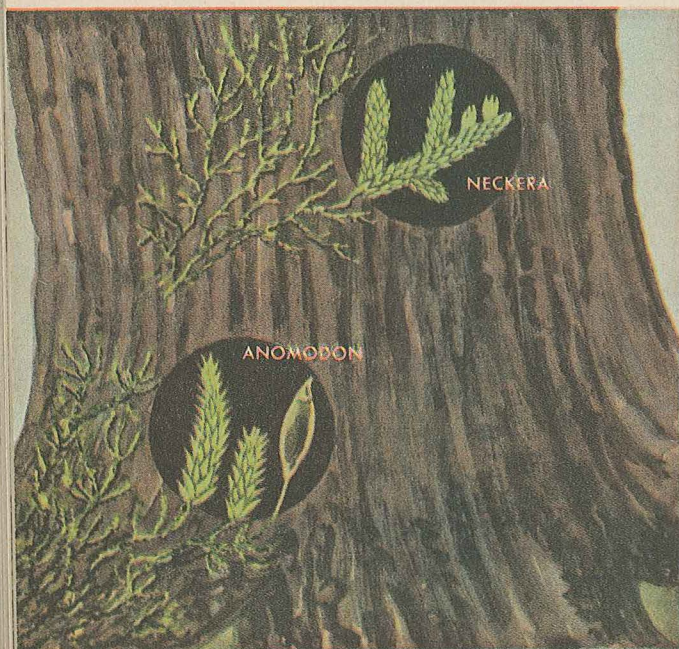
WAVY MOSS (CATHARINEA)

How do their leaves differ?

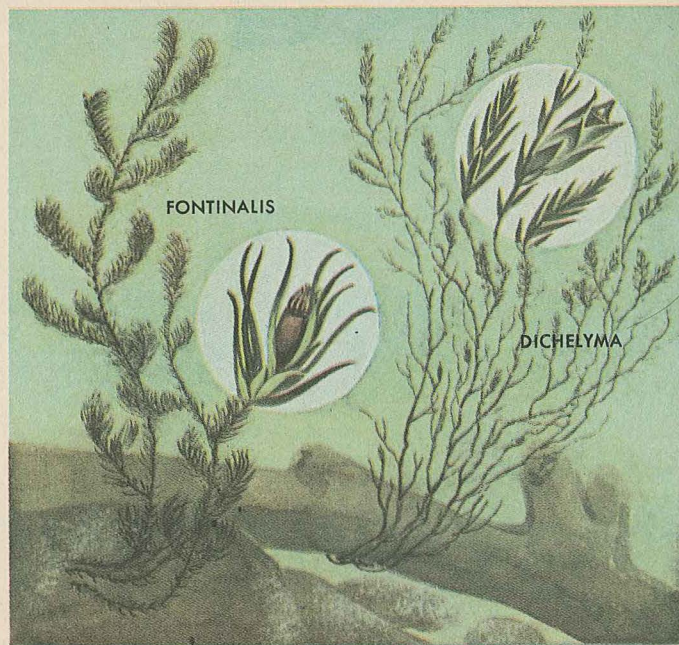
layer of cells except at the midrib or the thick margin of the

How do stems, fruits, and spores vary?

may be many-branched, slightly branched, or not



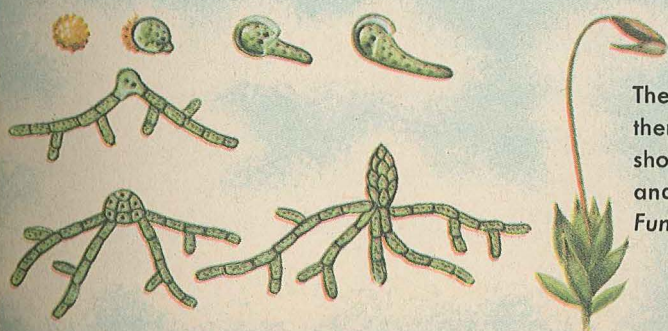
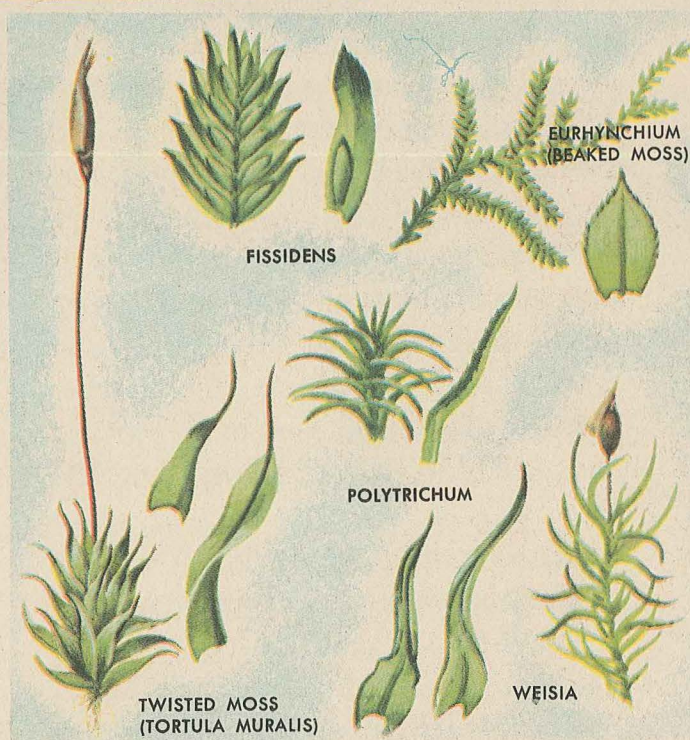
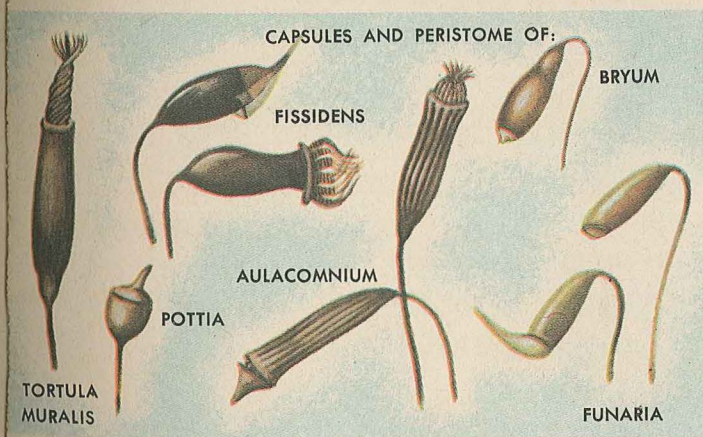
Some mosses make their home on live trees.



A few mosses are found in streams and ponds.

It always pays to be very observant on walks through your native woods. You may discover there many of the plants we have talked about, mushrooms, ferns, and mosses.

As much as the many species of moss may look alike on superficial inspection, a closer look reveals the many forms of leaves. Below, some mosses with leaves (enlarged) adjacent.



The contents of the capsules are spores, but a look at them under the microscope or a magnifying glass will show you that there is quite a variation in size, form, and surface. At left, we show the development of Funaria from spore to mature moss.

ding, or angular. Some capsules are smooth; others rib or contract when dry. The cap that covers the capsule may be hood-shaped or beaked; sometimes, it is hairy. It either falls off in the early stages or hangs on for a long time. In the Wavy Moss, the cap perches on one side of the capsule. Some mosses have no lid on the capsule. The capsules of others open one by one. The fringing ring — usually shading from red to orange, or yellow — around the capsule may be single, or double, with or without whole, split, or irregular teeth. In wet weather, these teeth close up tightly to keep the spores from being washed out. When dry, they separate and bend back to free the spores.

You may be able to find some moss in the fruiting stage. Examine the lower part of the stalk to see the leaf arrangement. Look at the leaves with a lens and note their color, shape, edging, and juncture to the stem. See if the stem of the fruit is the same color through its entirety. Tug at it to determine how its base is embedded in the tip of the plant. Study the veil to see if it is the same color. Examine the spore-capsule — count its sides, and look at its base on the stem. Pull its lid off and find the teeth around the edge. Try to shake some spore-dust from the capsule.

The spores of various mosses differ in size and surface; they are smooth, prickly, granulated, or sculptured.

The branching, trailing, thread-like mass of moss in its primary growth may cover only several inches or many feet of ground. Its branches descending into the earth may be brown or colorless. Prepare some slides and examine them under a microscope.



MOUNTAIN FERN MOSS (HYLOCOMIUM)

In some mosses, such as the Hairy-cap, male and female clusters grow on separate stems. In others, both are found on one stem. Male may be among female, in their own special clusters, or budding somewhere among the stems.

Mosses reproduce in various ways. In dry places, some do not form spores. Instead, the wind carries broken-off bits of leaves or branches, and when these fall in a suitable place, new plants begin if they have enough moisture to get a good start. New ones can grow from just a single moss leaf fed by water. You can see this if you put a leaf in a dish of water. Soon, fine green threads, growing on buds, will appear.

Some mosses are short-lived, but many continue to live from year to year, growing at the tips of stems and branches, or developing new plants from underground stems or spores.

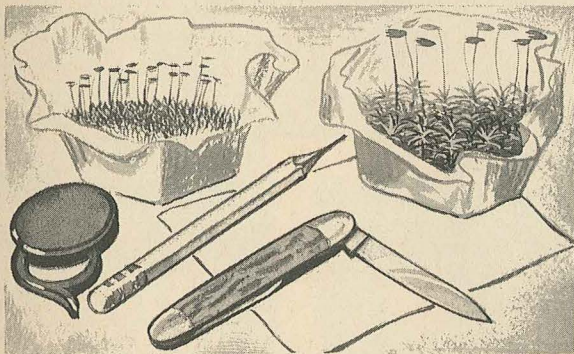
There are about 20,000 different kinds of mosses; about 5,000 are classified. There are two major groups of these plants. The *Acrocarpus* includes most of the common

How long do mosses live?

How many kinds are there?

varieties that stand erect and produce the spore plant at the top. Not branched at all or with only a few branches, they form a deep thick growth. The *Pleurocarpus* have fern-like or feathery branches on prostrate, ascending, or erect stems. They produce their spore generation on a short side branch. Many-branched, they often form thin tangled mats.

Some mosses are abundant and found almost everywhere. Certain species are but tufts of leaves and only a sixteenth of an inch tall; a few erect ones grow as high as twenty-four inches. Some trail over the ground; others interlace slender vines to form a thick mat. Some are flat, scale-like growths on earth, rocks, or trees. The feathery Fern Moss is such a moss. Its tiny, scale-like leaves overlap and look like cedar needles. This characteristic gives it the nickname of Cedar Moss. The *Mnium*, usually about a half-inch to three inches tall, has cylindrical spore-cases and bright green leaves that look like flower



Things you will need when you go out collecting moss.

petals. All have some green due to their chlorophyll content, the green being tinged with white, blue, gold, yellow, or olive. Peat Moss is pale green — almost white — with a tinge of red at the tip. Pincushion Moss, two or three feet

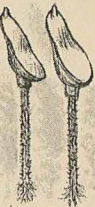
across, is soft and gray green in damp weather, but becomes white and crumbly during dry spells, giving it its other name of White Moss.

There are some unusual plants in the world of mosses. The *Buxbaumia* *Aphylla* looks like an inverted brown slipper on an absolutely leafless stalk. Some *Webera* have hair-like leaves around a small stemless cone that rests close to the ground. Scarcely an eighth of an inch high, the tiny *Ephemerum*'s little capsule is wrapped in toothed leaves like a miniature head of cabbage. In some *Climacium*, the leaves are clumped near the tops of the stalks, making the plants look like palm trees.

It is interesting to make a study of mosses by collecting them. To gather some specimens, take any convenient container,

a small paper sack or pieces of paper, a hand lens, and a knife with a three-inch blade. Gather several specimens of the same kind should some spoil or tear apart. Be sure to collect those with a capsule and stalk with enough leafy stem to show any branching that occurs. After cutting and wrapping them, record the date and place where each was found. To dissect the specimens, you will need fine forceps, two dissecting needles, micro-slides and covers, a bottle of water, a bottle of dilute glycerine, and a compound microscope. If you cannot examine a specimen at once, spread it between two blotters and put a weight over it. When it is dry, place it in a large envelope. When you are ready to study the moss, with your forceps, select a good shoot with a capsule. Soak it

BUXBAUMIA



WEBERA



CLIMACIUM

MNIUM



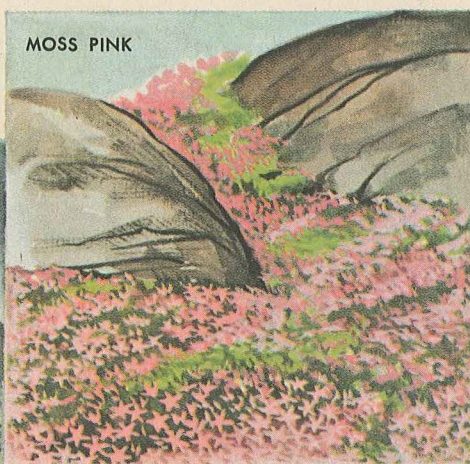
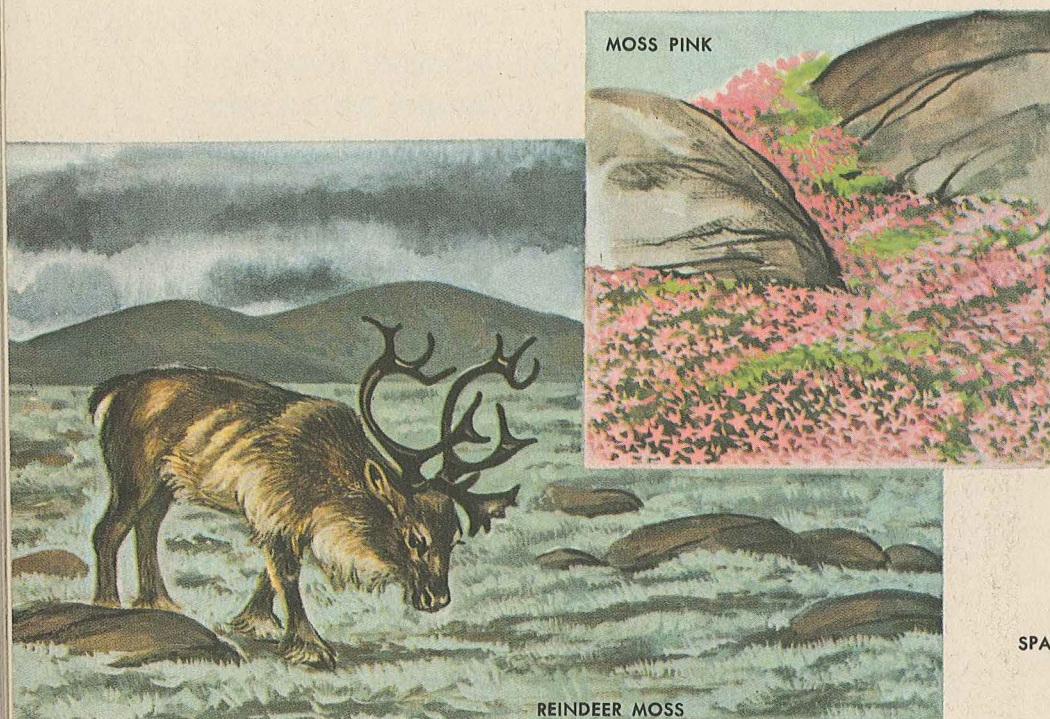
EPHEMERUM



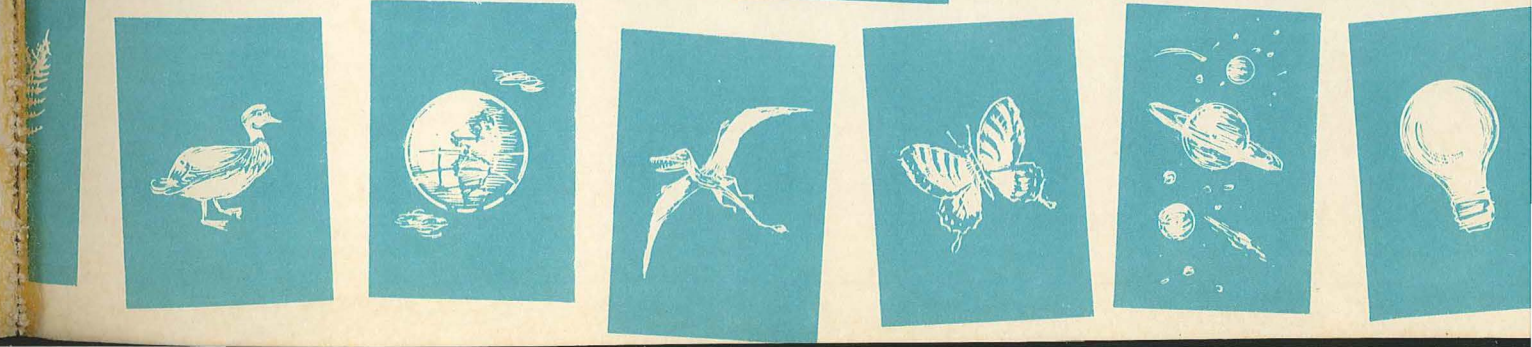
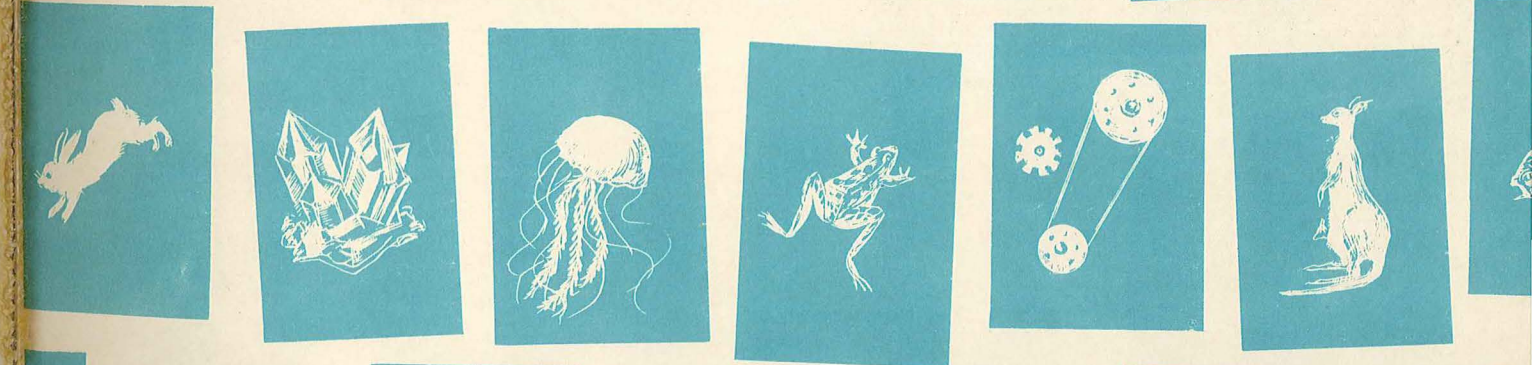
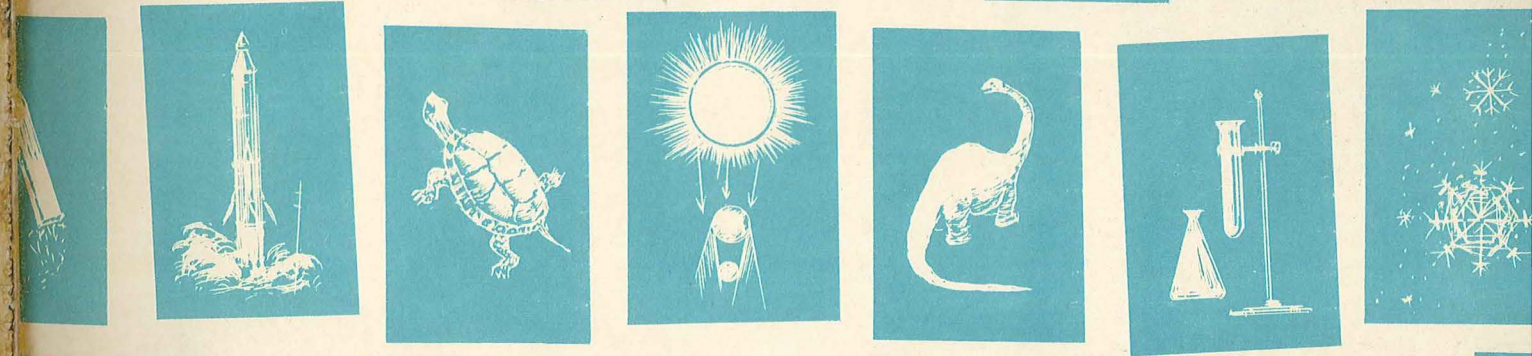
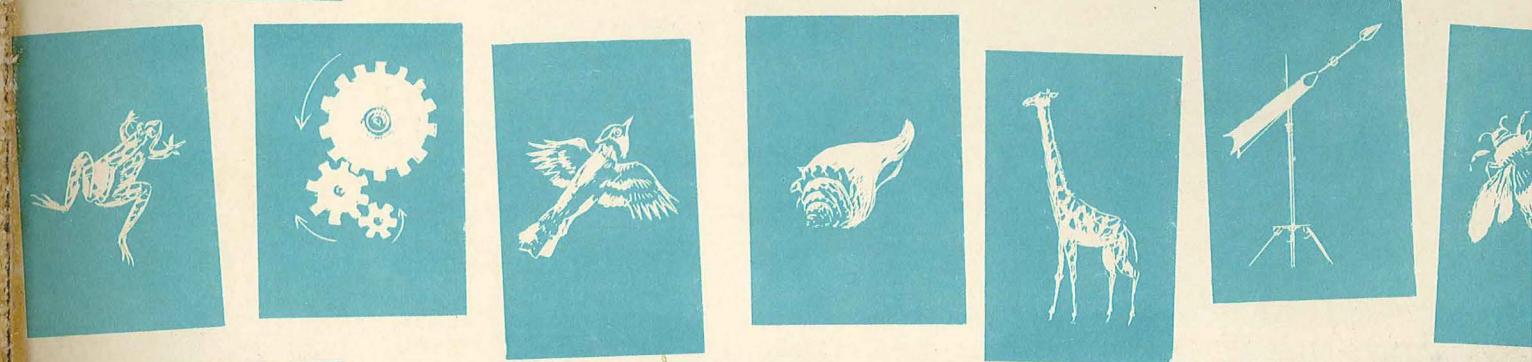
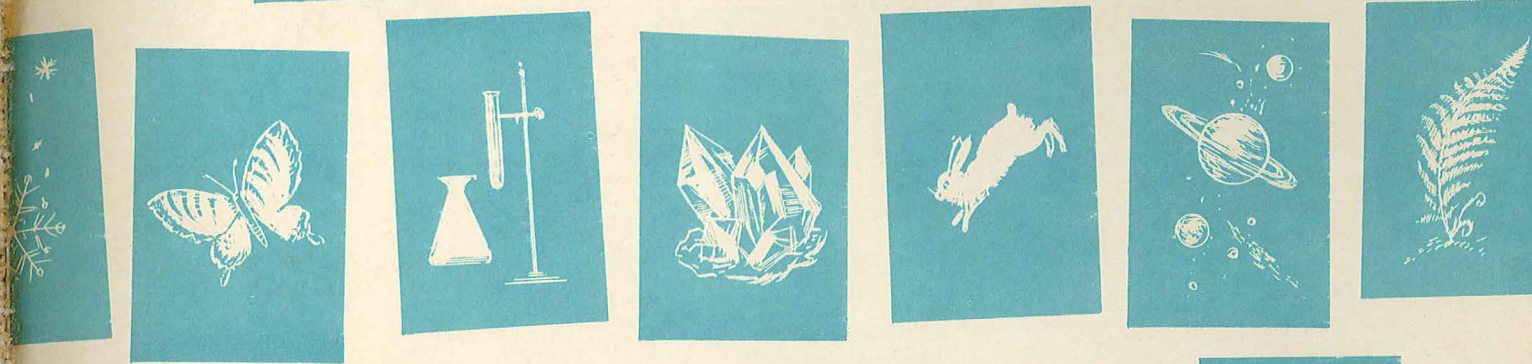
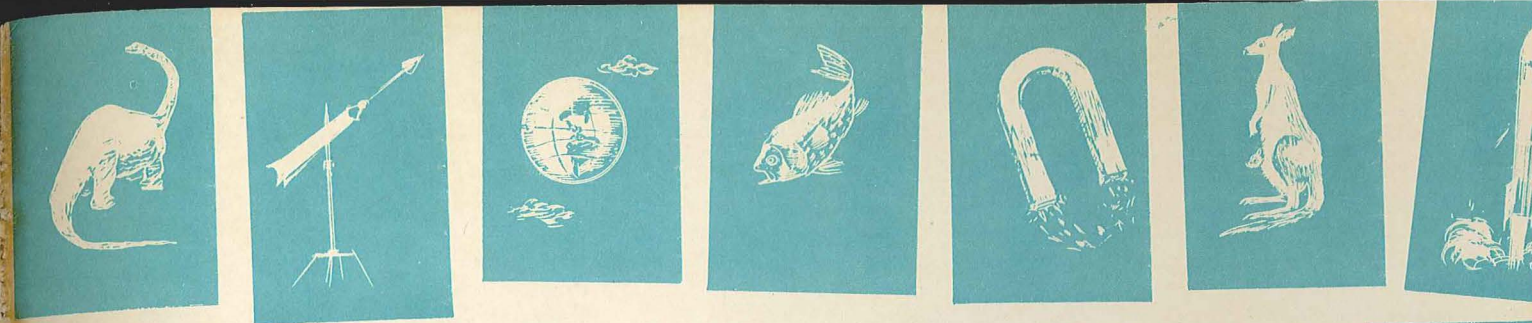
until it appears fresh, or dip it in boiling water. Lay a leafy shoot on a glass slide under the microscope. Hold it near the top with the forceps and scrape the stem down toward the base to remove some leaves. Remove the stem, spread out the leaves, cover, and examine through the lens. Cut away the capsule and lay it on a slide. Pry off the lid and see if it has a ring as it comes off. Cut the upper end of the capsule. Split the ring-shaped end into two or more pieces, laying one piece with its outer side up and the other with inner side up. Cover and study them. After the water dries away from under the cover glass, put a drop of

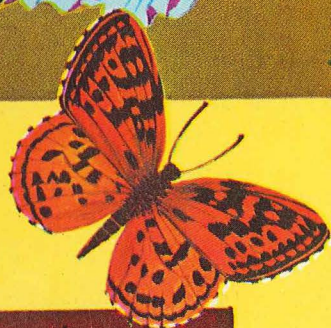
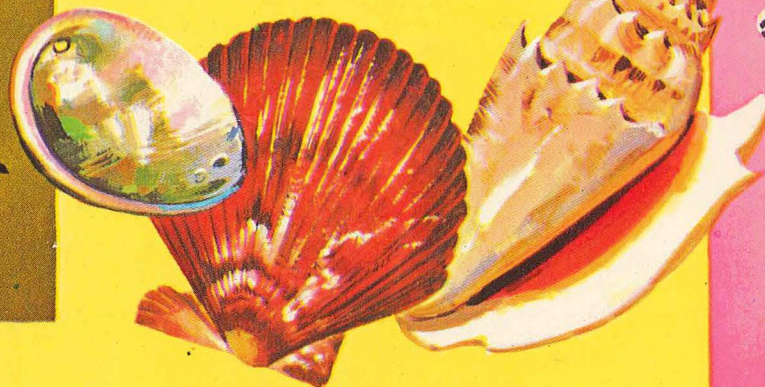
dilute glycerine at the edge of the cover. Label the specimen and store it in a cardboard box.

We hope that what you have read about mushrooms, ferns, and mosses has interested you so much that you will want to make a hobby of studying these primitive land plants, the lowest — but the oldest — order in the crowded plant kingdom. Looking at the illustration of the family tree of plants on page 4, it is hard to believe that all this could have happened between the day the first sea plant was thrown onto some bare rocks and the moment you picked up one of its descendants to start a collection.



The word "moss" in everyday speech is often wrongly used to describe many kinds of small plants which actually do not belong at all to the moss family. This is the reason why using popular names instead of Latin ones is so often deceiving. Club Mosses, for instance, are related to the ferns and not to the mosses, and the Reindeer Moss (*Cladonia rangiferina*), which covers large areas in Northern Europe and America, is a finely branched grayish lichen and not a moss. The name comes from the fact that it is the principal food of the reindeer. Spanish Moss (*Tillandsia usneoides*) is no more a moss than Moss Pink (*Phlox subulata*). Both are flowering plants; the former is a native of Florida growing on the branches of live oaks, and the latter, with its bright spots, adorns spring rock gardens. The British Carrageen Moss is an edible seaweed; when bleached, it becomes the Irish Moss of commerce. So don't you jump to such wrong conclusions when you hear somebody identifying a small plant as a moss. Always have a second look and try to determine for yourself whether it has the typical characteristics of the moss family.

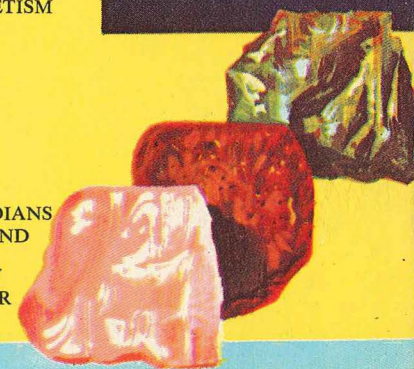
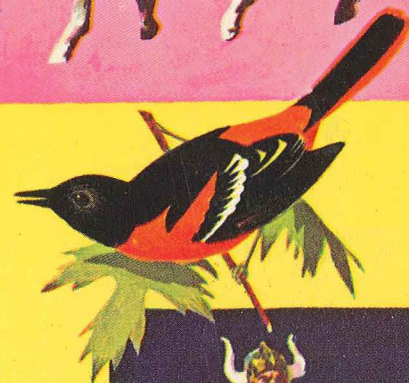




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